OFFICE OF THE PURCHASING AGENT

TOWN OF ARLINGTON
730 Massachusetts Avenue
Arlington, MA 02476

Telephone (781) 316-3003
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DATE: February 10, 2017

TO ALL BIDDERS

BID NO. 17-03

SUBJECT: RFP Commissioning Agent /Gibbs Middle School

**ADDENDUM NO. 1**

TO WHOM IT MAY CONCERN:

With reference to the bid request relative to the above subject, please note the following:

**SEE ATTACHED**

All other terms, conditions and specifications remain unchanged.

Very truly yours,

Town of Arlington

Domenic R. Lanzillotti
Purchasing Officer

# Gibbs Middle School Commissioning Agent ADDENDUM #01

Arlington, MA

## Request for Proposal (RFP) for Commissioning Agent

Issued February 01, 2017 - #17-03

### This hereby amends the RFP for Commissioning Agent #17-03 as of February 10, 2017:

*Commissioning Agent must acknowledge that they have incorporated this Addendum, including all attachments, in their proposal.*
*Note: Commissioning Agents are responsible for checking the website:*
http://www.arlingtonma.gov/departments/purchasing *for future Addenda prior to the bid date.*

**Below are all**

1. **Q:** Will the school be partially occupied with staff and students during construction?
   **A:** No, the school will not be occupied during construction

2. **Q:** What is the approximate construction cost?
   **A:** The approximate construction cost is $20 Million. The approximate cost is based off the Schematic Design estimate.

3. **Q:** Are schematic narratives available?
   **A:** The outline specifications issued with the Schematic Drawings can be found in Attachment #2 of this addendum.

   A set of Schematic Drawings are available to download. The link to download the files can be found in Attachment #3 in the RFP.

4. **Q:** What is the approximate square footage of the building?
   **A:** The approximate square footage of the building is 68,000 SQF.

5. **Q:** For Enhanced Commissioning, is the optional "Monitoring-Based Commissioning" being sought, which accounts for 2 points?
   **A:** Yes, Monitoring-Based Commissioning is being sought for the project.

6. **Q:** Is it required that a Massachusetts's registered mechanical engineer be on the commissioning staff?
   **A:** While a registered mechanical engineer is preferred, staff with commissioning certifications and commissioning experience are acceptable in lieu of MA professional engineering licenses.

7. **Q:** Is it required that a Massachusetts's registered electrical engineer be on the commissioning staff?
   **A:** While a registered electrical engineer is preferred, staff with commissioning certifications and commissioning experience are acceptable in lieu of MA professional engineering licenses.

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8. **Q:** LEED v4 is being pursued and the Enhanced Cx credit is part of that. The LEED scorecard indicates 4 points are going to be attempted as part of the Enhanced Cx credit. To clarify these four points are for Option 1: Path 1 (3 pts) & Path 2 (1 pt). Option 2: Envelope Commissioning (2 pts) is NOT being pursued?
   **A:** No, the project is not pursuing envelope commissioning due to the limited scope on the existing envelope of the building.

9. **Q:** The Fundamental Commissioning Prerequisite, which now requires design review of building envelope systems as well as MEP systems, will the building envelope encompass only exterior doors and limited roofing replacements?
   **A:** Yes, design review of construction documents for the building envelope including windows, doors, and limited roofing replacements.

10. **Q:** Are equipment counts available for this project? The RFP lists equipment types and functional testing sample percentages for each equipment type but does not have equipment counts. Is this information available for budgeting purposes?
    **A:** Please see the link in Attachment #3 of the RFP to download the Schematic Design drawings. Equipment counts can be found there.

11. **Q:** Page 5, Item 1 Commissioning Plan Phase, Deliverables – This item makes indirect reference to conducting a design review. Design reviews are part of the LEED commissioning requirements; however, the RFP does not call out the specific expectations for commissioning design reviews. To ensure all RFP respondents are providing the same scope of work, could you confirm the design review expectations (e.g. which sets of documents are to be reviewed - SD, mid-CD, final CD, etc.)?
    **A**: The Commissioning Agent will start by reviewing Design Development Documents, 60% Construction Documents, 90% Construction Documents, 100% Construction Documents, and Bid Documents.

12. **Q:** In several locations, the list of systems to be commissioned includes reference to fire protection systems, however the detailed list in Attachment 1 does not include fire protection. Could you confirm that fire protection systems are not included in the commissioning scope of work?
    **A:** No, commissioning of fire protection will not be included in the Commissioning Agent's scope. Disregard any references to fire protection in the RFP.

13. **Q:** In several locations, there are references to participation in or leading meetings as necessary. We understand the intent is likely to let the commissioning firm determine what is appropriate for this project, however, to ensure all RFP respondents are providing fee proposals for the same scope of work, could you quantify the number of meetings to be included in the bid? You could ask for a unit cost for additional meetings if desired.
    **A:** An estimated three meetings during design phase and a minimum of 1 meeting per month during the construction phase.

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14. **Q:** Page 10, VII Fee Section – The fee is requested as a Not to Exceed value. Could you confirm if the intent is to set up the contract as a lump sum fixed fee or hourly time and materials?
    **A:** The Commissioning Agent will bill using Time and Material, but will agree to a Not to Exceed total amount based on the scope described in the RFP and any issued Addendum.

15. **Q:** Page 11, VIII Qualifications – Bullet two requests registered engineers in mechanical, electrical, and plumbing. Will staff with commissioning certifications and commissioning experience be accepted in lieu of MA professional engineering licenses? If PE's are to remain a requirement, is it necessary to have both mechanical and plumbing?
    **A:** Please see answers to questions #6 & #7. Yes, while a registered engineer is preferred, staff with commissioning certifications and commissioning experience are acceptable in lieu of MA professional engineering licenses.

16. **Q:** A set of schematic design plans has been provided with the RFP. Is it possible to get an MEP systems narrative (typically included in the schematic outline specifications) or basis of design for the MEP systems?
    **A:** Please see Attachment #2 in this addendum. The MEP narrative can be found in the outline specifications that were issued with the Schematic Design drawings.

17. **Q:** pg. 5 Often the Owner and Architect work together to develop the OPR early in the design process. To what extent is the intent that the commissioning Agent will work with the Owner and Architect on developing the OPR?
    **A:** The Commissioning Agent is expected to advise and assist the design team and the owner during the development of the OPR.

18. **Q:** Pg. 6 "Attend Project construction meetings as frequently as necessary in the judgment of the Owner". This may lead to various different assumptions by bidders. Can you define what the Owner's expectations are on frequency?
    **A:** Please see answer to question #13 in this addendum.

19. **Q:** Pg. 8 "Check the installing contractors' field calibration of sensors and actuators during functional testing". Is the intention that the Commissioning Agent will review the calibration methodology and review documented results from the contractors related to testing, or is the Commissioning Agent being asked to physically field check 100% of sensors, actuators, etc.?
    **A:** Physically field check the percentages sought in options #1 and options #2 in the RFP. Review of calibration methodology is not required for this project.

20. **Q:** Pg. 8: "Witness and approve tests on HVAC equipment during both the heating and cooling season. "We typically specify appropriate testing during three seasons (Summer, Winter, and Fall or Spring seasons) in order to check economizer operation, etc. Is this also the intention of the RFP? Shall we include work for relevant Fall or Spring testing as well?

**A:** Yes, the Commissioning agent should include work for relevant Fall and Spring Testing.

21. **Q:** Pg. 9: Should the commissioning Agent plan to attend all of the training, or a relevant portion?
    **A:** Not required.

22. **Q:** Pg. 10: "Return to the site 12 months after substantial completion". Is it intended that after 12 months there will be another set of trend log reviews to verify all sampled equipment performance?
    **A:** Yes

23. **Q:** Pg. 18: Is it appropriate to propose an Option 3 with a modified sampling rate?
    **A:** No, conversations between the Commissioning Agent, Owner, and Design team regarding sampling rate modifications will occur after a commissioning agent has been chosen.

24. **Q:** Building envelope is listed on Pg. 7 for review. Is the intent that the commissioning Agent will provide commissioning of the building envelope, and what scope of testing is preferred?
    **A:** No, please see answer to question #8 in this addendum.

25. **Q:** Pg. 18: Building envelope is listed on Pg. 7 for review. Is the intent that the commissioning Agent will provide commissioning of the building envelope, and what scope of testing is preferred?
    **A:** No, please see answer to question #8 in this addendum.

26. **Q:** Pg. 18: Fire protection and life safety engineering are listed on Pg. 4 as systems to be commissioned. Is the intent that the commissioning Agent will provide commissioning of these systems?
    **A:** No, please see answer to question #12 in this addendum.

27. **Q:** Could you please comment on which options/points are anticipated for LEED Enhanced Commissioning? Will an MBCx (Monitoring-Based Commissioning) plan be required?
    **A:** Yes, MBCx (Monitoring-Based Commissioning) is being sought in this project. Please see answer to question #5 in this addendum.

28. **Q:** The proposal requests not to exceed pricing. There are some commissioning related items which can have variable costs which are out of our control. For example:
    - Multiple reviews of the same submittal if required.
    - Repeated functional tests due to a lack of preparedness or failed testing by the contractor.

- Multiple TAB report reviews due to incomplete work by the contractor.

**A:** The Commissioning Agent should expect the estimated number of meetings mentioned in the answer to Question #13 in this addendum. As always, the Commissioning agent is expected to attend relevant, unanticipated meetings as they arise during the course of the project as well as relevant, unanticipated tasks.

## ATTACHMENTS

Attachment #1 – Updated LEED Scorecard (02/03/17)
Attachment #2 – MEP Narrative (In outline spec. issued with Schematic Design drawings)

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# Attachment #1

Updated LEED Scorecard (02/03/17)

**LEED for Schools v4**
**Project Scorecard**

| | | |
|---|---|---|
| Bld SF: | | |
| Site SF: | | |
| FTEs: | | |
| Visitors: | | |
| Parking #: | | |

Project Name: Gibbs School
Project Address: 48 Tufts St, Arlington, MA 02474
Date Updated: Feb 3, 2017

**May require additional cost**

**Targeted LEED v4 Rating: Certified**

| Phase | Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 9 | 1 | 2 | 5 | | **Project Information** | 0 | Respons. | STATUS | Notes |
| D | Y | | | | PIf1 | **Project Information** | | FAA / TGE / Bala/TMP | | |

| Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | | **Integrative Process** | 1 | Respons. | STATUS | Notes |
| D | | | 1 | IPc1 | **Integrative Process** | 1 | ART, Bala/TMP, | | Requires Performing a preliminary “simple box” energy modeling analysis before the completion of schematic design that explores how to reduce energy loads in the building and accomplish related sustainability goals by questioning default assumptions. Assess at least two potential strategies associated with the following:<br>· Lighting levels. Assess interior surface reflectance values and lighting levels in occupied spaces.<br>· Thermal comfort ranges. Assess thermal comfort range options.<br>· Plug and process load needs. Assess reducing plug and process loads through programmatic solutions (e.g., equipment and purchasing policies, layout options).<br>· Programmatic and operational parameters. Assess multifunctioning spaces, operating schedules, space allotment per person, teleworking, reduction of building area, and anticipated operations and maintenance. |

| Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 1 | 0 | 5 | | **Location & Transportation** | 15 | Respons. | STATUS | Notes |
| D | | | | 0 | LTc1 **LEED for Neighborhood Development Location** | 15 | | | |
| D | 1 | | | | LTc2 **Sensitive Land Protection** | 1 | Nitsch | | not in area with wetlands, water body, farmlands,etc |
| D | | | | 2 | LTc3 **High Priority Site** | 2 | | | |
| D | 5 | | | | LTc4 **Surrounding Density and Diverse Uses** | 5 | TGE | | in a dense area and neighborhood has access to amenities. Prelim. Calculations done to confirm points |
| D | 2 | | | 2 | LTc5 **Access to Quality Transit** | 4 | TGE | | 2 points for access to buses. Prelim. Calculations done to confirm points |
| D | | | | 1 | LTc6 **Bicycle Facilities** | 1 | | | no showers in school |
| D | 1 | | | | LTc7 **Reduced Parking Footprint** | 1 | Nitsch | | parking is limited. Requires allocating carpool parking spaces for 5% of total parking. |
| D | | 1 | | | LTc8 **Green Vehicles** | 1 | Nitsch | Owner Decision | Parking is limited. Requires installing EV stations for 2% of spaces plus LEFE spaces for 5% of all spaces (or provide a discounted parking rate). Electric charging stations might not be a good fit for this project. A hookup for a future charging station was discussed. There is also a Green Buses option for this credit.<br><br>Getting cost from SDC to review with Owner. Keep as maybe. |

| Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 0 | 5 | 4 | | **Sustainable Sites** | 12 | Respons. | STATUS | Notes |
| C | Y | | | SSp1 | **Construction Activity Pollution Prevention** | Required | Nitsch/ Shawmut | | the design team will prepare an erosion and sedimentation control plan and detail sheet as part of their submission. |
| D | Y | | | SSp2 | **Environmental Site Assessment** | Required | | | |
| D | 1 | | | | SSc1 **Site Assessment** | 1 | FAA/ Nitsch/ DMLA | | We will likely need this point. Credit can be done for an existing building. |
| D | | | | 2 | SSc2 **Site Development - Protect or Restore Habitat** | 2 | | | |
| D | | | | 1 | SSc3 **Open Space** | 1 | DMLA | | Need to provide outdoor space greater than or equal to 30% of the total site area. A minimum of 25% of that outdoor space must be vegetated (turf grass does not count as vegetation) or have overhead vegetated canopy. |
| D | | | 3 | | SSc4 **Rainwater Management** | 3 | Nitsch | | Requires managing on site the runoff from the developed site for the 95th percentile of regional or local rainfall events using low-impact development (LID) and green infrastructure. Not likely |
| D | | | 2 | | SSc5 **Heat Island Reduction** | 2 | TGE/ DMLA/ FAA | | Need a light colored roof and light colored surfaces to achieve this credit. |
| D | 1 | | | | SSc6 **Light Pollution Reduction** | 1 | ART | | Full cut off lighting will be installed. Calculations will need to be done to determine credit compliance |
| D | | | | 1 | SSc7 **Site Master Plan** | 1 | | | |
| D | 1 | | | | SSc8 **Joint Use of Facilities** | 1 | School/ FAA | | It is the intention of the project that the Auditorium, Gymnasium, playing fields and parking will be shared spaces with the general public |

| Yes | Maybe | Likely No | No | | Water Efficiency | 12 | Respons. | STATUS | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 1 | 0 | 5 | | | | | | |
| D | Y | | | WEp1 | **Outdoor Water Use Reduction** | Required | DMLA | | |
| D | Y | | | WEp2 | **Indoor Water Use Reduction** | Required | Bala/TMP / TGE | | |
| D | Y | | | WEp3 | **Building-level Water Metering** | Required | Bala/TMP / School | | |
| D | 2 | | | WEc1 | **Outdoor Water Use Reduction** | 2 | DMLA | | Confirmed- Native Plants should make this achievable |
| D | 3 | 1 | | 3 | WEc2 | **Indoor Water Use Reduction** | 7 | Bala/TMP / TGE | BALA to confirm | 3-4 points possible if we use 1.1 g/ flush WCs, and .35 lavs. Without this we earn 1 point. AND All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labeling must be WaterSense labeled AND Prerinse spray valves, Commercial clothes washers, Dishwashers, Food steamers, Food waste disposer, and Combination ovens must meet specific water reduction requirements. |
| D | | | | 2 | WEc3 | **Cooling Tower Water Use** | 2 | | | |
| D | 1 | | | | WEc4 | **Water Metering** | 1 | Bala/TMP | | Yes, point should be anticipated. |

| Yes | Maybe | Likely No | No | | Energy & Atmosphere | 31 | Respons. | STATUS | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 6 | 3 | 15 | | | | | | |
| C | Y | | | EAp1 | **Fundamental Commissioning and Verification** | Required | | | |
| D | Y | | | EAp2 | **Minimum Energy Performance** | Required | Bala/TMP | | |
| D | Y | | | EAp3 | **Building-level Energy Metering** | Required | Bala/TMP / School | | |
| D | Y | | | EAp4 | **Fundamental Refrigerant Management** | Required | Bala/TMP | | |
| C | 4 | 1 | | 1 | EAc1 | **Enhanced Commissioning** | 6 | | Owner decision | CxA will be performed. Enhanced commissioning will require additional cost. |
| D | 2 | 3 | | 11 | EAc2 | **Optimize Energy Performance** | 16 | Bala/TMP | TGE | |
| D | 1 | | | | EAc3 | **Advanced Energy Metering** | 1 | Bala/TMP ART | | Yes. Electric power monitoring in currently included. |
| C | | | | 2 | EAc4 | **Demand Response** | 2 | | | |
| D | | | 2 | 1 | EAc5 | **Renewable Energy Production** | 3 | Bala/TMP ART | | |
| D | | | 1 | | EAc6 | **Enhanced Refrigerant Management** | 1 | Bala/TMP | | |
| C | | 2 | | | EAc7 | **Green Power and Carbon Offsets** | 2 | School/ TGE | Owner decision | Green power could be purchased if additional points are needed. |

| Yes | Maybe | Likely No | No | | Materials & Resources | 13 | Respons. | STATUS | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 6 | 0 | 4 | | | | | | |
| D | Y | | | MRp1 | **Storage & Collection of Recyclables** | Required | School/ FAA | | We will provide sufficient collection and storage space for all required recyclables. Also need to provide 2 of the following: e-waste, batteries and mercury containing lamps |
| C | Y | | | MRp2 | **Construction and Demolition Waste Management Planning** | Required | Shawmut | | |
| C | 2 | 2 | | 1 | MRc1 | **Building Life-cycle Impact Reduction** | 5 | FAA | | If at least 25% of building materials are reused or salvaged (as a percentage of the surface area), we can achieve a point. For 4 points, reuse 75% or greater of building materials. |
| C | | 1 | | 1 | MRc2 | **Building Product Disclosure and Optimization**-Environmental Product Declarations | 2 | FAA/ Shawmut | | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | | 1 | | 1 | MRc3 | **Building Product Disclosure and Optimization**-Sourcing of Raw Materials | 2 | FAA/ Shawmut | | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | | 1 | | 1 | MRc4 | **Building Product Disclosure and Optimization**-Material Ingredients | 2 | FAA/ Shawmut | | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | 1 | 1 | | | MRc5 | **Construction and Demolition Waste Management** | 2 | Shawmut | Shawmut to confirm 2nd point | Project will need to divert at least 50% of construction waste from at least three Material Streams. Need to have separate dumpsters **on site** for at least three streams to get 1 point. |

| Yes | Maybe | Likely No | No | | Indoor Environmental Quality | 16 | Respons. | STATUS | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 3 | 7 | 1 | | | | | | |
| D | Y | | | IEQp1 | **Minimum IAQ Performance** | Required | Bala/TMP | | |
| D | Y | | | IEQp2 | **Environmental Tobacco Smoke (ETS) Control** | Required | FAA/ School/ TGE | | |
| D | Y | | | IEQp3 | **Minimum Acoustical Performance** | Required | Acentech | | Once the drawings and specifications are sufficiently developed, Acentech will review them with an emphasis on surface finishes and HVAC noise. They expect that it will be fairly straightforward to meet the LEED requirements for NRC, but it will likely be more difficult to meet the noise level (dBA) limit. Acoustical upgrades that may be necessary for the HVAC systems serving classrooms and core learning spaces include relatively long attenuators at rooftop packaged units, fully lined supply air and return air ductwork, and FCUs sized for medium speed (maximum) operation. |
| D | 2 | | | | IEQc1 | **Enhanced IAQ Strategies** | 2 | Bala/TMP / FAA | | Project will have walk off mats, MERV 13 filters, and carbon dioxide monitoring |
| C | | 1 | 1 | 1 | IEQc2 | **Low-Emitting Materials** | 3 | FAA/ Shawmut | | Specifications can be written to help achieve at least one point for this credit |
| C | 1 | | | | IEQc3 | **Construction IAQ Management Plan** | 1 | Shawmut | | Project will develop and implement an indoor air quality (IAQ) management plan |
| C | | | 2 | | IEQc4 | **IAQ Assessment** | 2 | Shawmut | Owner/Shawmut decision | Flushout is a weak maybe. Timeline for occupancy after construction completion will be tight. If air quality testing is done, can earn two points and don't have to wait as long for flushout. However, must pass testing or will have to retest. Testing has an added cost. |
| D | 1 | | | | IEQc5 | **Thermal Comfort** | 1 | Bala/TMP | | Need confirmation that HVAC systems will be designed to meet requirements of ASHRAE Standard 55–2010 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| D | 1 | 1 | | | IEQc6 | **Interior Lighting** | 2 | ART | ART input needed | Quality lighting option is a second point. Confirmation needed on quality lighting. at least 90% of individual occupant spaces will have individual lighting controls. Multi occupant spaces should meet light requirements. |
| D | | | 3 | | IEQc7 | **Daylight** | 3 | FAA | | Calculations / modeling would need to be done to determine if this credit is achieveable |
| D | | 1 | | | IEQc8 | **Quality Views** | 1 | TGE | TGE | Calculations would need to be done to determine if this credit is achieveable |
| D | | | 1 | | IEQc9 | **Acoustic Performance** | 1 | Acentech | | Acentech expects that this credit will be cost-prohibitive due to stringent requirements for sound isolation at classrooms and core learning spaces. To earn this credit, it would be necessary to upgrade the roof and it may be necessary for communicating doors to have a minimum acoustical rating of STC 45-50. |

| Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 2 | 0 | 0 | | **Innovation** | 6 | Respons. | STATUS | Notes |
| | | | | | | | | | |
| D | 1 | | | | INc1 | **Innovation in Design: Green cleaning** | 1 | Team | | Green cleaning was discussed |
| D | 1 | | | | INc2 | **Innovation in Design: Building as an educational tool** | 1 | Team | | Building as an educational tool was discussed |
| D | 1 | | | | INc3 | **Innovation in Design: low mercury lighting** | 1 | Team | | |
| C | | 1 | | | INc4 | **Innovation in Design: Possible Pilot credt ideas - Prevention through Design, Ergonomics approach for computer users, Clean construction, Learning controls for thermal comfort, Active Design** | 1 | Team | Team Decision | |
| C | | 1 | | | INc5 | **Innovation in Design: To be determined** | 1 | Team | | |
| C | 1 | | | | INc6 | **LEED Accredited Professional** | 1 | TGE | | |

| Yes | Maybe | Likely No | No | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 2 | | **Regional Priority Credits - earn up to 4 points** | 4 | Respons. | | |
| | | | | | Area code: 02474 | | | | |
| | | | 1 | Credit 1 | **Renewable Energy Production** (threshold: 2 points) | 1 | | | |
| | | | 1 | Credit 2 | **Optimize Energy Performance** (threshold: 8 points) | 1 | | | |
| | | | 0 | Credit 3 | **High Priority Site** (threshold: 2 points) | 1 | | | |
| | | 1 | | Credit 4 | **Rainwater Management** (threshold: 2 points) | 1 | | | |
| | | | 0 | Credit 5 | **Cooling tower water use** | | | | |
| 1 | | | | Credit 6 | **Building Life-Cycle Impact Reduction** (threshold: 2 points) | | | | |

| Yes | Maybe | Likely No | No | | |
|---|---|---|---|---|---|
| 38 | 19 | 17 | 36 | | **Project Totals (Certification Estimates)** 110 |

**Certified:** 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points

**Gibbs Middle School Commissioning Agent ADDENDUM #01**
Arlington, MA

# Attachment #2

MEP Narrative (In outline spec. issued with Schematic Design drawings)

OUTLINE SPECIFICATIONS

# GIBBS SCHOOL
ARLINGTON, MA

November 23, 2016

ARCHITECT
**Finegold Alexander Architects, Inc.**
77 North Washington Street
Boston, MA 02114
617-227-9272
www.faainc.com

FA # 43917.00

**DOCUMENT 000120**

**OUTLINE SPECIFICATIONS**

**SCHEMATIC PHASE- CONSTRUCTION ASSEMBLIES AND SYSTEMS**

Project Description
A - Substructure
B - Shell
C - Interiors
D - Services
E - Equipment and Furnishings
F - Special Construction and Demolition
G - Building Sitework
Z - General Requirements
Appendices
Drawing List

(Note: Sections in *italics* will be in bidding and Contract Documents, but are not in these Outline Specifications)

## PROJECT DESCRIPTION

10: GENERAL

1010 – Project Summary

- Renovation of a 6 grade public school in Arlington, MA
- Approximate building square footage: 69,000 gsf.
- Sustainable Design Intent: Comply with LEED V4 requirements.
- Hazardous Material Abatement and Demolition: Per survey.
- Site: Refer to drawings, narratives, and outline specifications.

1020 – Project Program

- Refer to drawings for program elements.

1030 – Existing Conditions

- General scope for work on existing building includes, but is not limited to the following:
  - Wood trim and moldings repair and restoration.
  - Gutter and downspout replacement.
  - Exterior stair and railing repair.
  - Masonry infill.
  - Window and door replacement.
  - Masonry repointing, repairs, and cleaning (clay masonry, limestone, and as indicated).
  - Interior demolition and renovations.
  - Chimney repairs, including masonry and copper cap/louver repairs.
  - Roof replacement, including low-slop EPDM membrane roof and sloped roof with asphalt shingles and felt underlayment.

1040 – Owner's Work

- Owner will remove all existing furnishings and movable equipment prior to construction.

1050 – Funding

- Local funding.

20: PROPOSAL, BIDDING AND CONTRACTING

2010 – Delivery Method

- Construction Manager at Risk with Trade Sub-Contractors as required by Massachusetts Public Bid Laws.
    - Anticipated Trade-Bid categories:
        - MASONRY
        - MISCELLANEOUS AND ORNAMENTAL IRON
        - WATERPROOFING, DAMPPROOFING AND CAULKING
        - ROOFING AND FLASHING
        - METAL WINDOWS
        - GLASS AND GLAZING
        - TILE
        - ACOUSTICAL TILE
        - RESILIENT FLOORS
        - PAINTING
        - ELEVATORS
        - PLUMBING
        - FIRE SUPPRESSION
        - HVAC
        - ELECTRICAL WORK

2020 – Qualification Requirements

- Bidders for General Construction and Trade Sub-Bid trades shall be Pre-Qualified according to Massachusetts Public Bid Laws.

- Bidders for General Construction and Trade Sub-Bid trades shall be DCAMM certified for their category of work.

2030 – Proposal Requirements: Not Applicable.

2040 – Bid Requirements

- Bidding procedures according to Massachusetts Public Bid Laws

2050 – Contracting Requirements

- Contracting procedures according to Massachusetts Public Bid Laws

30: COST SUMMARY

3010 – Elemental Cost Estimate: Refer to Study Cost Estimate.

3020 – Assumptions and Qualifications: Refer to Study Cost Estimate

3030 – Allowances: Not Applicable

3040 – Alternates: Not Yet Determined

3050 – Unit Prices: Not Yet Determined

## A. SUBSTRUCTURE

A10: CAST IN PLACE CONCRETE

Refer to structural drawings and attached narrative.

A1010 – Standard Foundation Supplementary Components

- Minor repair to crushed/spalled foundation wall.

A1030 – First Floor Construction

- Repair entry steps.
- Cutting and patching for new plumbing
- Equipment pads.

## B. SHELL

B10: SUPERSTRUCTURE

Refer to structural drawings and attached outline specifications.

B1010 – STRUCTURAL STEEL FRAMING

B1010 – Floor Construction

- CMU seismic support at CMU walls to remain.
- Rebuild existing ramp 2nd floor.
- Reframing at floor openings.
- New penetrations to existing structure.
- Infill of existing stair opening.
- Firestopping floors.

B20: EXTERIOR ENCLOSURE

B2010 – Exterior Walls

- Repoint/repair existing brickwork.
- Repair masonry site walls.

- Infill abandoned exterior louvers in masonry walls.
- Repair rested steel lintels/angles.
- Repair spalled/corroded concrete wall reinforcing.
- Remove and replace damaged section of inside face of exterior wall at South Façade third floor.

B2020 – Exterior Windows and Louvers

- Aluminum windows, fixed and operable type windows, thermally broken.
- Insulating glass assembly: Two panes of 1/4-inch glass with 1/2-inch argon-filled space, and solar control low-e coating.
- Backer rod and double sealant.
- Wood blocking at openings.
- Aluminum storm-proof louvers for combustion air finished to match windows.

B2030 – Exterior Doors

- Stile-and-rail aluminum doors with aluminum frames at main entrances.
- Galvanized steel doors and frames at service entrances, and door hardware.
- Backer rod and sealant.
- Wood blocking at openings.

B2040 – Curtain Wall and Storefront

- 6-inch deep framing, field glazed with insulating glass assemblies as for exterior windows.
- Sloped entrance curtainwall.

<u>B30: ROOFING</u>

B3010 – Roof Coverings

- EPDM membrane roofing, typical: Fully adhered EPDM roofing with sloped polyisocyanurate insulation, 1/2-inch gypsum protection board with glass mat facing and 6-mil reinforced vapor barrier. EPDM membrane roofing shall be white at typical locations.
- Aluminum clad canopy.
- Roof accessories: Aluminum roof edges, scuppers, gutters and downspouts, copings, and flashings.

- Patching of existing roof to remain for new MEP.
- New roof ladder from grade.

B3020 – Roof Openings

- Elevator venting (reuse existing)

B3030 – Miscellaneous Roof components

- Entrance canopy aluminum column covers.

**C. INTERIORS**

C10: INTERIOR CONSTRUCTION

C1010 – Partitions

- Type-X gypsum wallboard on 6 inch or 3-5/8-inch steel studs, typical.
  - Level 5 finish is required for Lobbies, Cafeteria and Media Center.
  - High impact drywall at designated areas
  - Batt insulation in stud partitions.
- CMU: 8-inch thick, normal-weight.
  - Decorative polish-ground CMU where indicated.
- Shaftwall at mechanical/plumbing chases.

C1020 – Interior Doors and Frames

- Metal frames, typical: Formed steel and sidelights.
- Wood doors, typical: Flush doors with factory-finished maple veneer.
- Door Hardware.
- Sound gasketed doors for Music and Auditorium.
- Acoustic rated communicating doors.
- Overhead coiling doors for kitchen serving.
- Operable partition, electrically operated, Modernfold or equal.

C1030 – Fittings Specialties

- Acoustic wall panels in Music, Auditorium and Cafeteria, and as indicated.
- Utility and closet shelving.
- Toilet Accessories.

- Sliding glass enclosed tackboards in Corridors.
- Markerboard and tackboards.
- Interior signage including building directory and dedication plaque.
- Phenolic toilet partitions and urinal screens; misc metal to support.
- Student double tier lockers.
- Athletic lockers (small, lockable).
- Custom transparent finish maple millwork including display cases, cubbies, bookcases, tiered seating, and Library/Admin./Security desks.
- Fire protection specialties.
- Decorative column covers.
- Frameless mirrors.
- Staff mailboxes/casework.
- Janitor's closet accessories.
- Media Center ciruclation desk.
- Reception desk at Administration.

C20: STAIRS

C2010 – Stair Construction

- Steel pans with concrete fill.
- Steel picket type guardrails.
- Painted steel railings

C2020 – Stair Finishes

- Steel structure and pans shop-primed for field painting.
- Rubber treads, risers and landings, typical stair and ramp locations.

C30: INTERIOR FINISHES

C3010 – Wall Finishes

- All finishes to be low VOC.
- Water-based latex system, typical: Primer with two finish coats

- High-performance system for corridors, stairways, toilet rooms: Epoxy primer with two polyurethane finish coats
- Ceramic tile for corridor, glazed tile, thin-set.
- Ceramic tile for toilet room, glazed tile, thin-set.
- FRP panels in custodial closets.

C3020 – Floor Finishes

- Poured epoxy at kitchen.
- Moisture mitigation below rubber flooring and carpeting on concrete slabs on grade.
- Rubber tile, typical
- Carpet for Administration, Guidance, Library and Auditorium: CRI Green Label carpet, adhered to concrete
- Ceramic tile for toilet rooms: unglazed porcelain tile, thin-set.
- Linoleum floor tile.
- Patch wood sports floor in Gymnasium.
- Sealed concrete.
- Rubber base.
- Resilient sheet sports flooring in multipurpose room.

C3030 – Ceiling Finishes

- 2x2 acoustical ceiling tile, typical.
- 2x2 vinyl acoustical ceiling tile in kitchen.
- Exposed painted steel structure and deck in Auditorium.
- Gypsum wallboard at breakout nodes, toilet rooms.
- Drywall soffits.
- Spray acoustic treat at gymnasium ceiling.
- Music room ACT and GWB ceilings.
- Suspended acoustical ceiling clouds with formed metal trim.

**D. SERVICES**

D10 CONVEYING SYSTEMS

D1010 – Elevators and Lifts

- Replace elevator cab and mechanisms.
- Lift at platform and mezzanine (in media center)

D20: PLUMBING

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D2010 – Plumbing Fixtures

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271500 – Communications Horizontal Cabling

275319 – Public Safety Radio Distributed Antenna System (DAS)

283111 – Addressable Fire Alarm System

## E. EQUIPMENT AND FURNISHINGS

E10: EQUIPMENT

E1010 – Commercial Equipment

- Commercial food service equipment for Kitchen.

E1020 – Institutional Equipment

E1030 – Vehicular Equipment

E1090 – Other Equipment

- Residential appliances including: refrigerators, microwave ovens, dishwashers, and electric ranges.
- Athletic equipment including: Folding basketball backstops, scoreboards, shotclocks, volleyball standards, climbing wall, divider curtain, and wall pads.
- Electric operated projection screens.
- Emergency eyewash/shower cabinets.
- Kiln hoods.

E20: FURNISHINGS

E2010 – Fixed Furnishings

- Recessed interior foot grilles and frames in vestibules, and recessed floor mats and frames at entrance corridors.
- Manually and electrically operated window shades.
    - Dual roller, solar shades and blackout shades in Science rooms.
    - Motor operated in Gymnasium, Auditorium and Media Center, and where indicated.
- Horizontal blinds at interior borrowed lights and doors.

E2020 – Movable Furnishings

E2030 – Manufactured Casework.

- Maple storage cabinets with maple doors and drawers in classrooms and where indicated.
- Laminate and epoxy resinous counters in classrooms and where indicated.
- Lab casework and fixtures.

- Instrument storage.

## F. SPECIAL CONSTRUCTION AND DEMOLITION

F20: SELECTIVE DEMOLITION

F2010 – Building Elements Demolition

- Removal of existing interior partitions where indicated, doors, casework, finishes as required to accommodate new construction shown on Drawings.
- Removal of existing mechanical and electrical work as required to accommodate new construction shown on Drawings.
- Salvaging plaques, carved relief panels, and sitework items.
- Remove existing windows/curtainwall.
- Remove exsting CMU walls.
- Demolish stairs where indicated.
- Demolish floor slabs where indicated.
- Remove floor ifnishes.
- Remove ceilings.

F2020 – Hazardous Components Abatement - Refer to summary report.

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**DOCUMENT A SUBSTRUCTURE**

**OUTLINE SPECIFICATION**

**SCHEMATIC PHASE - CAST-IN-PLACE CONCRETE**

## PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment, related hand tools, and perform all operations required for complete installation of cast-in-place concrete and related work, as shown on the Drawings.

1.2 STANDARDS

A. ACI 211.1 “Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete.”

B. ACI 304 “Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.”

C. ACI 301 “Specifications for Structural Concrete for Buildings.”

D. ACI 214 “Recommended Practice for Evaluation of Compression Strength Test Results of Concrete.”

E. ACI 304 “Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.”

F. ACI 315 “Manual of Standard Practice for Detailing Reinforced Concrete Structures.”

G. ACI 318 “Building Code Requirements for Reinforced Concrete.”

H. CRSI-WCRSI “Placing Reinforcing Bars.”

I. AWS D1.4 “Structural Welding Code - Reinforcing Steel.”

1.3 SUBMITTALS

A. Submit shop drawings and placing drawings for all reinforcing steel.

B. Furnish certified mill test reports for cement, metal reinforcing and welded wire fabric.

1.4 QUALITY CONTROL

A. Verify that the total chloride ion and sulfate content of each mix is within the specified limits.

B. Test cylinders of concrete to verify strength.

C. Verify for air content in accordance with ASTM C231-82.

D. Testing and inspection shall be by an independent agency paid for by the Owner.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. The total chloride ion content shall not exceed 0.10% and the total sulfate content 0.5% by weight.

B. Portland Cement ASTM C150 Type II.

C. Admixtures Air-entraining per ASTM C260. Other admixtures with prior written approval only.

D. Water Conform to ACI 301, Chapter 2, Paragraph 2.3.

E. Aggregate ASTM C33 including Appendix XI.

F. Metal Reinforcing ASTM A615 Grade noted on Drawings.

G. Welded Wire Fabric ASTM A185.

H. Vapor Barrier Polyethylene sheeting 6 mils thick of approved manufacture.

2.2 MIXES

A. Design Mixes in accordance with ACI 211.1.

B. Prepare design mixes prior to the beginning of work in accordance with ACI 301 Chapter 3 Paragraph 3.8 Method 1 or 2 and Paragraph 3.8.3.

C. The strength of concrete shall be in accordance with the requirements of the Structural Drawings.

D. Air entrain all concrete exposed to weathering in accordance with ACI 301 Chapter 3 Paragraph 3.4 determined by volume as per ASTM C231.

END OF SECTION A10 SUBSTRUCTURE

**DOCUMENT B10: SUPERSTRUCTURE**

**OUTLINE SPECIFICATION**

**SCHEMATIC PHASE – STRUCTURAL STEEL FRAMING**

A. DESCRIPTION OF WORK

1. Structural steel for building construction and related anchors, fasteners, and connectors.

B. QUALITY ASSURANCE

1. Standards: AISC, Code of Standard Practice for Steel Buildings and Bridges, and applicable regulations.

2. Testing: Independent testing laboratory.

3. Erection Tolerances: AISC standards.

C. PRODUCTS

1. Steel Materials:

   a. Structural Steel Shapes, Plates, and Bars: ASTM A992.
   b. Cold-Formed Steel Tubing: ASTM A 500, Grade B.
   c. Hot-Formed Steel Tubing: ASTM A 501.
   d. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.
   e. Steel Castings: ASTM A 27, Grade 65-35.
   f. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020.
   g. Anchor Bolts: ASTM A 307, nonheaded type.
   h. Unfinished Threaded Fasteners: ASTM A 307, Grade A.
   i. High-Strength Threaded Fasteners: ASTM A 325 or ASTM A 490, as applicable.

2. Auxiliary Materials:

   a. Direct Tension Indicators: ASTM A 959.
   b. Electrodes for Welding: AWS Code.
   c. Structural Steel Primer Paint: SSPC - Paint 1, red lead and oil.
   c. Structural Steel Primer Paint: SSPC - Paint 2, red lead-iron oxide, oil alkyd.
   c. Structural Steel Primer Paint: SSPC - Paint 13.
   d. Cement Grout: Portland cement, sand.
   e. Metallic Shrinkage-Resistant Grout: Premixed ferrous aggregate grouting compound.
   f. Nonmetallic Shrinkage-Resistant Grout: Premixed nonmetallic grouting compound, CE CRD-C621.

END OF SECTION

**DOCUMENT 000120**

**OUTLINE SPECIFICATION**

**SCHEMATIC PHASE- CONSTRUCTION ASSEMBLIES AND SYSTEMS**

## PROJECT DESCRIPTION

## A. SERVICES

D20: PLUMBING

D2010 – General Requirements

- Scope includes demolition of the existing toilet room fixtures, fittings and service piping.
- Reuse of existing domestic water service mains is to be determined, subject to test and analysis.
- Existing above and below floor sanitary, waste, vent and interior storm piping requires inspection and analysis.
- The existing natural gas service will be reviewed for new and existing-to-remain equipment demands.
- The existing domestic water service is adequate; the water provider should review the existing meter.
- New work includes toilet room, kitchen and casework fixtures.
- A new domestic hot water plant will be provided, including mixing valves and circulators.
- Scope includes plumbing connections to Kitchen equipment and point-of-use, recessed grease traps.
- Work shall be performed in accordance with the MA Building and Plumbing Codes and the Local Authority.
- Work shall be performed by Contractors who are licensed to practice in the State.
- File and pay for all permits, fees, certificates, inspections and approvals.
- Equipment and materials shall be new, high grade commercial quality, and installed in accordance with the MA Plumbing Code and the Contract Documents.

D2010 – Plumbing Fixtures

- Toilet Room fixtures shall be wall-hung, vitreous china.

- Casework fixtures shall be 18 gauge, stainless steel.
- Provide water efficient fixtures and fittings.
- Lavatory faucets at 0.5 gallons per minute.
- Urinal flush valves at 0.125 gallons per flush.
- Toilet flush valves at 1.28 gallons per flush.
- Casework faucets at 1.2 gallons per minute.
- Owner shall determine if Toilet Room faucets and flush valves are to be hands-free, sensor type.
- Include drains, hose bibbs, valves, fittings, hangers and accessories.
- Include cleaning and testing of all fixtures, equipment and piping systems.

D2020 – Domestic Water Distribution

- Provide a new domestic water meter if directed by the water provider.
- A domestic water booster system is not required.
- Domestic hot water shall be set up to be generated by natural gas.
- Provide all accessories, devices and building pumped circulation loops.
- Set up shall include a gas-fired storage heater, two mixing valves, two circulators, and one expansion tank.
- An electric hot water booster (by Kitchen Equipment Contractor) will be required in the kitchen for the dishwasher, 140°F to 180°F.
- All domestic water piping shall be insulated.
- Provide disinfection of all domestic water piping systems.

D2030 – Sanitary Waste

- The existing building sanitary exits are expected to remain.
- Partial re-use of existing below-slab, cast iron piping is intended, pending observation and testing.
- Provide sanitary, waste and vent piping to all fixtures and floor drains.
- Include a dedicated "kitchen waste" piping system to the exterior grease trap (exterior structure by Site/Civil).

- Provide floor drains and local grease interceptors for the pot sink, dishwasher and kettles.

D2040 – Storm Water Drainage

- Internal roof drainage systems from flat roof areas are expected to remain.
- Insulate roof drain bodies and all rainwater piping.
- Gutters and downspouts are not included in the Plumbing section.

D2050 – Other Plumbing Systems

- Modify the existing natural gas piping to serve heating equipment, the domestic hot water plant and Kitchen equipment.
- The Gas Company will review the existing meter based on the revised connected load.
- Sub-meters can be provided under this Section to monitor gas consumption by heating boilers, rooftop units and the domestic hot water plant if requested.
- Non-potable water and acid waste systems are not anticipated.

D2060 – Plumbing Specialties

- Specific system requirements.
- All plumbing and gas connection work associated with Kitchen equipment indicated on Food Service drawings.
- Cross-connection control (backflow preventers) for irrigation, HVAC systems, and Science Classrooms.
- Responsibility and supervision of the flue gas venting of all gas-fired devices.
- Gas train vents associated with all gas-fired equipment and gas meters.
- Freeze-proof wall hydrants (fed off of the irrigation supply).
- Waste outlets to accept HVAC condensate and sprinkler waste discharges.
- Insulation of all domestic and non-potable water piping, roof drain bodies, storm water piping, water cooler drain piping and all exposed piping at handicapped fixtures.
- Pipe and equipment identification, valve tags and charts.
- Project coordination process.
- Provide Firestopping

- Provide shop and record drawings.
- Provide Owner and Maintenance Manuals.
- Provide testing of all piping systems.
- Provide sleeves, escutcheons, hangers and miscellaneous steel supports, including seismic restraints.
- Include drilling for installation of inserts.
- Provide pipe and equipment identification.
- Provide scaffolding, hoisting and rigging.
- Provide pressure gauges.
- Include system and equipment start-ups; Owner instructions.
- Include seismic expansion loops.
- Pipe Materials:
    - New water piping shall be type "L" copper with 95/5 lead free solder joints.
    - New gas piping shall be black iron, screwed to 2 inch, welded 2-1/2 inch and above.
    - Storm water piping shall be service weight cast iron, no hub with mechanical couplings above grade; hub and spigot with neoprene gaskets below grade.
    - Sanitary, waste and vent systems shall be service weight cast iron, no hub with mechanical couplings above grade; hub and spigot with neoprene gaskets below grade.
    - Galvanized for small vents and DWV copper for miscellaneous drains and vents.
    - Insulation, at a minimum, shall be in accordance with the Energy Code.
- Manufacturers:
    - Intended specified manufacturers.
    - Gas-fired, storage heater high efficiency: PVI, Patterson Kelly.
    - Local grease interceptors, JR Smith, Wade.
    - Plumbing fixtures: American Standard, Kohler.
    - Drains, miscellaneous accessories: J.R. Smith, Watts.

- Wall hydrants: Woodford, J.R. Smith.
- Valves: Watts, Apollo.
- Flush Valves: Sloan (Royal).
- Backflow preventers, safety devices, vacuum breakers: Watts.
- Insulation: Owens Corning.
- Mop receptors: Stern-Williams, Fiat.
- Water coolers: Halsey Taylor, Haws, Oasis.
- Sinks: Elkay, Just.
- Hose bibbs, misc. outlets: Chicago, Woodford.
- Circulators: Taco.
- Mixing valves: Leonard, Powers, Symmons, Lawler.
- Trap primers: Precision.
- Seismic expansion loops: Metraflex.
- Water hammer arrestors: Smith, Zurn, Josam.
- Expansion tanks: Amtrol.
- Emergency equipment: Haws, Guardian.
- Cyst/Lead reduction filters: Halsey Taylor.

- Related Work in Other Sections:
  - Concrete work.
  - Toilet room accessories
  - Cutting and patching.
  - Installation of access panels in ceiling and wall construction.
  - Painting.
  - Electric power wiring for all equipment.
  - Structural supports necessary to distribute loading from equipment.
  - Casework fixtures and fittings (installation only by Plumber).

- Site drainage and utilities.
- Fire service piping and drains.
- Excavation, trenching and backfilling.
- Specification and design flue of gas venting system.
- Flashing of roof penetrations and setting sump receivers.
- Food service equipment.

D30 HEATING, VENTILATING AND AIR CONDITIONING

D3000 – General Requirements

- Provide a new high efficiency central heating, ventilating, and air conditioning system consisting of two new gas-fired condensing hot water boilers and one air cooled liquid chiller (ACLC) and multiple self-contained rooftop air conditioning units (RTU). The hydronic heating and cooling system will serve a two-pipe dual temperature piping loop with automatic chilled/hot water changeover, utilizing common piping. The piping system will contain a 30% propylene glycol solution for freeze protection. The base system serving classrooms will utilize two-pipe console hydronic fan coil units (FCU) with one or two FCU's provided for each typical classroom. Interior occupied spaces will be served either by supply air from a rooftop unit or by a variable refrigerant flow (VRF) system with FCU's to allow for summer operation without activating the chiller and to allow for air-conditioning in the Winter Season. Classrooms and other spaces served by FCU's will be ventilated by dedicated outside air rooftop heat recovery systems (HRU). Assembly areas will be handled by dedicated rooftop air conditioning units (RTU). These units will be variable volume.

- Chiller plant will not have any back-up capacity. The hot water boiler system will have between 67% and 80% backup capacity should one boiler fail depending on boiler sizes used. Condensing boilers utilize lower design supply water temperature (160°F maximum) that requires derating of heating terminal unit capacities and thus may require larger unit sizes.

- All normally occupied areas will be air conditioned except corridors and kitchen. Corridors are provided with ventilation air or building exhaust makeup air only whichever is greater, and are typically not fully conditioned with the exception of areas that have direct solar loads. Kitchen is partially tempered by using transfer air from Cafeteria for make-up air.

- Occupied spaces will be conditioned to 75°F during cooling season and 72°F during heating season. Unoccupied cooling season temperatures for classrooms served by the dual temperature piping system are not controlled since the chiller is typically off. Unoccupied heating temperature is 60°F (+/-) adjustable.

- Two-pipe changeover system serves fan coil units in perimeter classrooms. It shall feature twice a year automatic conversion of the central piping system from heating to cooling (between April 15th to May 1) and from cooling to heating (be-

tween October 1 to October 15th). Unusually warm days in the heating season may result in space temperatures above set point and cold days in the cooling season may result in space temperatures below set point. Alternative four pipe systems that allow simultaneous heating and cooling have proven to be uneconomical for the minimum number of days where space temperature may vary slightly from design temperature set point.

- Classrooms will be ventilated by two rooftop heat recovery units (HRU) featuring supply and exhaust fans and total energy recovery wheels. Heating will be by hydronic hot water heating coils. Cooling will be self-contained direct expansion (DX). One unit will serve the South Zone classrooms and one unit will serve the North Zone classrooms. Corridor ventilation will be provided by the HRU's. The supply air temperature from each unit may be separately adjusted to provide effective preconditioning of outside air depending on outside air temperature conditions and solar loads.

- Auditorium/ Stage, Media Center, and Cafeteria are served by self-contained DX rooftop air conditioning units (RTU). The RTU systems will have full economizer cooling. Therefore cooling is available beyond the mechanical cooling season at times when internal loads require cooling. Rooftop air conditioning units (RTU) include self-contained DX cooling with integral air-cooled condensing unit and hydronic heating. These units will be either variable volume single zone with or without variable air volume terminals.

- Administration area and classrooms in the 1973 addition will be heated and cooled by a heat recovery type VRF system with ceiling recessed or concealed FCU's. Ventilation will be provided by a roof mounted energy recovery ventilator (ERV). This unit will include supply fan, exhaust fan and an energy recovery wheel, but will not have cooling capability.

- Gymnasium will be heated and ventilated only by two interior suspended heating and ventilating air handling units with hot water heating coils. Unit will be capable of providing 100% outside air economizer cooling during colder weather conditions.

- Design Conditions:

    - Chapter 13 - Energy Conservation of the Massachusetts State Building Code for Middlesex County Climate Zone/13a: Outside: Winter 7°F; Summer 87°F DB/74°F WB. Inside: 72°F heating, 75°F cooling. Controls for unoccupied temperature setback will be provided.

    - Outside Ventilation Air: Outside air will be provided in accordance the International Mechanical Code at an average rate of approximately 15 cfm/person for classrooms, except in science, art, and music rooms which will be approximately 20 CFM/person.

- Hot Water Heating System:

    - Heating will be provided by lower temperature hot water (160°F maximum supply 130°F return), which will be provided by two new gas-fired condensing

hot water boilers along with the use of the newer existing cast iron boiler, which will be converted from steam to hot water heating.

- The plant will be sized to provide a minimum of 67%, but no more than 80%, of full capacity upon failure of one boiler. This allows for full heating of the building on most days without reducing outside air and during a peak heating design day with some reduction of ventilation air.

- The main pumping system will be designed with three pumps at 50% capacity each. One or two pumps will normally run continuously in the heating season and during occupied mode only in cooling season as a heating pump for indoor comfort reasons (Heating of air at minimum ventilation rates when overcooling occurs.). The third pump will be for standby operation.

- Individual occupied spaces will be heated with multi-row fin tube radiation, fan coil units, convectors, cabinet unit heaters, unit heaters, or VAV terminal heating coils.

- A dedicated hot water piping loop designed to serve the heating only equipment shall be provided throughout the building as required. The dual temperature piping loop will serve the classroom two-pipe FCU's.

- Air Conditioning System:

  - Chilled water will be generated by a high-efficiency roof-mounted packaged air-cooled chiller. There will be no back-up capacity for chiller system should the unit fail.

  - During the cooling season as defined previously, the system will be converted to supply chilled water to fan coil units. Seasonal changeover valves located in the central mechanical room will be positioned to provide chilled water only.

  - The main water pumps with variable speed drives (VSD's) will provide chilled water during the cooling mode. One or two pumps may be operated depending on system demand.

  - Provide split systems with indoor DX evaporator coil and exterior ACCU, as indicated on plans to serve IT, Nurse’s Room, elevator machine rooms, etc.

- Exhaust Systems:

  - Exhaust systems will be provided for toilet rooms, electric rooms, and janitor's closets which will be ducted to either dedicated roof-mounted exhaust fans or to HRU or ERV exhaust fans.

  - The kitchen hood will be provided with a dedicated roof-mounted kitchen exhaust fan designed for grease exhaust systems. The motor will be two-speed to allow for cooking and non-cooking modes of operation.

  - Dedicated exhaust fans will also be provided for the kiln, dishwasher and trash room.

- Building Management System (BMS):
  - A Direct Digital Control (DDC) automatic temperature control (ATC) system shall be utilized. System shall be Johnson Controls FX with a local and a web based interface. Main DDC panels shall control all HVAC systems and shall perform day/night scheduling for all unitary equipment.
  - All thermostats will be protected with lockable blank covers and guards. Thermostats will be non-readable and non-adjustable. Thermostats in non-supervised area will have heavy duty wire guards.
  - All gas and electric monitoring and check meters will be connected to the BMS system to log data and provide reports.
  - 100% outside air heat recovery units will be provided with an outside air temperature reset control to vary the unit supply temperature. The supply air temperature will be adjusted between: Cooling 55°F +/- and Heating 74°F based on outside air temperature. This schedule may also be adjusted separately for each unit. Primary cooling and heating of classrooms will be provided by two-pipe fan coil units.
  - CO2 based demand control ventilation will be provided for the gymnasium, cafeteria, and auditorium. Outside air will be adjusted from a minimum up to a maximum set point based on the space CO2 levels.
  - Individual zone thermal control via space thermostat for each heating and cooling zone. All packaged system controls shall be furnished by BMS manufacturer to provide 100% compatibility with central system.
  - All central HVAC systems shall be controlled by local DDC control panels. An automatic dial up/out web-based notification will be provided for remote reporting of alarms and system access.
  - VAV terminals will control the amount of air to individual spaces via individual room thermostats in the space and will maintain minimum ventilation rates. Variable frequency fan drives (VFD) shall control the supply and return air fans for all variable air volume units. Space sensor shall reset the discharge air temperature for constant volume units. VFD's will also be used on constant volume systems to allow for two speed operation (Gym); to offset filter loading impact on air delivery.
  - Provide a new high efficiency central heating, ventilating, and air conditioning system consisting of two (2) new gas-fired condensing hot water boilers and one air cooled liquid chiller (ACLC) and multiple self-contained rooftop air conditioning units (RTU). The hydronic heating and cooling system will serve a two-pipe dual temperature piping loop with automatic chilled/hot water changeover, utilizing common piping. The piping system will contain a 30% propylene glycol solution for freeze protection. The base system serving classrooms will utilize two-pipe console hydronic fan coil units (FCU) with one or two FCU's provided for each typical classroom. Interior occupied spaces will be served either by supply air from a rooftop unit or by a variable refrigerant flow (VRF) system with FCU's to allow for summer operation with-

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- Auditorium/ Stage, Media Center, and Cafeteria are served by self-contained DX rooftop air conditioning units (RTU). The RTU systems will have full economizer cooling. Therefore cooling is available beyond the mechanical cooling season at times when internal loads require cooling. Rooftop air conditioning units (RTU) include self-contained DX cooling with integral air-cooled condensing unit and hydronic heating. These units will be either variable volume single zone with or without variable air volume terminals.

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- Gymnasium will be heated and ventilated only by two interior suspended heating and ventilating air handling units with hot water heating coils. Unit will be capable of providing 100% outside air economizer cooling during colder weather conditions.

D3020 - Heat Generating Systems

- Packaged condensing type gas-fired boiler and burner as manufactured by Lochinvar, Fulton, or AERCO Benchmark Series.

- Boilers will be provided with lead-lag controls. Boiler controls for lead/lag and compensated water temperature control will be furnished by boiler manufacturer and connected to central system for alarms.

- Each boiler shall have an individual double walled gas venting system. Individual vents will vent the domestic hot water heaters through the roof.

- Combustion air will be provided for boilers by a modulating combustion air supply system, (Exhausto, Tjernlund, or equal) through a louver located at the exterior wall of the Boiler Room. Domestic water heaters will have direct combustion air connections.

- Provide an emergency switch at entry to boiler room to shut off gas supply to boilers and to the domestic hot water heater. Provide CO detectors in Boiler Room.

D3030 - Cooling Generating Systems

- Air-cooled liquid chiller (ACLC) as manufactured by Aaon, Daikin Applied, Johnson, Trane or Carrier.

- Unit shall be completely factory assembled, complete with compressors, evaporator, condenser, refrigerant and oil operating charges, microprocessor control system, single point power connection, and vibration isolation.

- Manufacturer shall provide start-up service, training, O&M Manuals, and parts and labor warranty.

- The chiller shall use scroll compressors utilizing HFC R-410a. The chiller performance shall meet the minimum efficiency requirements for utility rebates and shall exceed the requirements of the state energy code.

- The final size of the ACLC will be determined based on the cooling load less the cooling capacity provided by the HRU through the ventilation air system. The base chiller size is approximately 60 tons.

- Provide multiple air cooled condensing units for dedicated split systems and/or VRF-FCU systems.

D3040 - Distribution Systems

- Ductwork:
  - Galvanized sheetmetal for HVAC supply, return, outdoor air and exhaust ductwork. Kitchen hood exhaust to be 10 gauge welded black iron. Dish-washer ductwork to be stainless steel.
  - Gauges and construction - SMACNA - low velocity 2 inch and 4 inch pres-sure class duct connection standards with all joints and seams sealed.
  - Provide spiral round duct for exposed ductwork conforming to the standards for 10 inch pressure class ductwork. Round ducts shall be the product of SEMCO, United Sheet Metal, USM, or LINDAB. Sheetmetal gauges and construction for circular ducts shall be SMACNA high pressure spiral lock seam with slip joints.
  - Acoustical duct lining shall be provided in supply and return air ducts where indicated near the unit connections and transfer air ducts.
  - Sound attenuators shall be utilized at all fan and rooftop unit connections to provide sound control.
- Piping and Appurtenances:
  - Hot water, chilled water and dual temperature water piping shall be carbon steel Schedule 40 for 2-1/2 inch and larger with welded joints, except where flanges are required for valves or equipment. Piping 2 inch and smaller shall be Type L copper with 95/5 solder joints.
  - Condensate drain piping shall be Type L copper. Refrigerant piping shall be Type L copper.
  - Provide strainers, unions, valves, anchors, guides, expansion loops, flexible connectors, fittings, bellows type expansion joints, hangers, insulation shields and other appurtenances as required.
  - Air separator, 125 psig working pressure. ASME label. TACO, Bell & Gossett, AMTROL or approved equal.
  - Expansion tanks (Diaphragm type): water system with ASME construction. TACO, Bell & Gossett, AMTROL or approved equal.
  - Provide specialty refrigeration piping components for VRF/FCU systems.

D3050 - Terminal & Package Units

- Rooftop HVAC Units (RTU): Rooftop units to be double walled construction with foam insulation and be provided with supply and return fans, mixing section,

MERV-13 dual filter banks complete with filter gauge(s). All units shall include a means of positively measuring the outdoor airflow. Variable air volume units shall have VFD's for supply and return fans. Units shall be Aaon, Daikin Applied, or Valent.

- Classroom Ventilation (HRU): Rooftop heat recovery units shall contain double wall construction, supply and exhaust fans, self-contained DX cooling, hydronic heating coils, MERV-13 filters with 2 inch prefilters, total energy recovery wheel. Greenheck, Daikin Applied, or American Aldes.

- Kitchen Makeup Air Unit (MAU): Hot water heating make-up air unit with modulating face and bypass dampers, 2 inch MERV-8 filters, to provide outside air make-up for kitchen hood exhaust. Daikin Applied, Trane or Carrier.

- Fan Coil Units (FCU): Two-pipe fan coil units, vertical console type cabinet (floor mounted) and/or horizontal ceiling models, as manufactured by International Environmental, Daikin, Trane, or Johnson/Envirotech. Units shall be tested and certified in accordance with ARI Standard 441, latest edition and UL listed. Fan coils will be sized to meet cooling capacity at medium or low speed to meet acoustical requirements. Horizontal fan coil units shall be ducted on both the supply and return airflows.

- Fan Coil Units - (VRF) Dakin, Mitsubishi, or LG multiple VRF-FCU will be connected to central air cooled condensing units (ACCU). Utilize three pipe VRF systems with heat recovery sequences allowing simultaneous heating and cooling of various spaces connected to same ACCU.

D3060 - HVAC Instrumentation & Controls

- Direct Digital Control (DDC) building management system with local and unitary controls and web interface for remote access, alarms and monitoring. All control systems, including manufacturer packaged control systems shall comply with BACnet communications protocol. Controls shall be Johnson FX.

D3070 - HVAC Systems Testing, Adjusting and Balancing

- All air and water systems shall be balanced to the required quantities. Balancing contractor shall work in cooperation with the commissioning agent during the commissioning process, including additional tests as required to confirm proper system operation.

D3090 - Other Special HVAC Systems and Equipment

- Exhaust Fans: Roof mounted exhaust fans for toilet rooms, dishwasher hood, and miscellaneous exhaust systems. Wall mounted or in-line exhaust fans for standby and emergency electric room, main electric room, and mechanical room. Fans to be Geenheck, Cook, or Acme. Provide upblast discharge type SWSI aluminum roof fan for kitchen hood rated for NFPA 96 Kitchen exhaust duty. Provide with aluminum insulated 18 inch high roof curbs and motorized dampers.

- Pumps: Base mounted end suction types to be Taco, Paco/Grundfos or Bell and Gossett. Cast iron casing, bronze impellers, with mechanical seals. Ball bear-

ings and open drip-proof motors. VSD compatible motors complete with VSD (variable speed drives) for pumping capacity control.

- Insulation: Water Piping: heavy density sectional fiberglass with factory applied jacket and vapor barrier. Provide on fittings and valves. HVAC supply air duct-work shall be externally insulated, with 1-1/2 inch thick 1.5 lb. density fiberglass with factory applied vapor barrier jacket. Outside air plenums and ducts: 2 inch thick, 6 lb. density fiberglass with factory applied vapor barrier.

- Valves: Provide manual shut-off valves and unions in each connection to each piece of equipment or coil to permit isolation and servicing. Drain valves: bronze body, hose threads with cap and chain. Hot water shut-off and balancing valves: lug type butterfly valves on piping 2-1/2 inch and larger and ball valves on smaller sizes. Provide isolation valves at all major branches and at all piping at entrance to shafts at each floor.

- Vibration Control and Seismic Restraint: Vibration isolators for suspended fans, HVAC units and air cooled chillers. Seismic spring vibration isolation curbs shall be provided for mounting of rooftop units where indicated. Flexible connectors at all fan connections and pumps. Flexible spring hangers for piping in and within 50 feet of mechanical room. All equipment shall be seismically restrained as per the Massachusetts Building Code.

- Water Treatment: Provide for dual temperature, hot and chilled water systems: 5 gallon manual bypass feeder, valves and piping. Provide 30% propylene glycol system solution for freeze protection.

- Hot water unit heaters, cabinet unit heaters, convectors and finned tube radiation and enclosure.

- Supply, return and exhaust ductwork, including low and medium pressure supply ductwork.

- Dual temperature, chilled water, hot water, and condensate drain piping, valves and fittings.

- Double-walled stainless steel boiler stacks and breeching. Separate stacks will be provided for the hot water boilers and domestic hot water heater.

- Draft inducing fan complete with controls for manifolded boilers.

- Grilles, registers and diffusers.

- Condensate piping and traps for all units with cooling coils. Condensate pumps for all FCU at First Floor.

- Variable air volume (VAV) terminal boxes with hot water reheat coils.

- In-duct sound attenuators.

- Expansion tanks (Diaphragm type) and air separator for piping system.

- Variable frequency drives for VAV system(s), and dual temperature pumps.
- Split system, DX cooling units for Tech Rooms and Tel/Data rooms.
- Chemical treatment and glycol for freeze protection of circulating water systems.
- Testing and balancing of all air and water systems.
- Operation and Maintenance (O&M) Manuals.
- HVAC Contractor shall provide coordination with Commissioning Agent and attendance at commissioning meetings.
- Premium efficiency motors.

D3095 - HVAC ALTERNATES

- Alternate M1 – Delete roof-mounted air-cooled liquid chiller for classroom dual temperature fan coil system. Chilled water piping from boiler room through roof penetrations shall remain for potential future use. Structural roof supports shall be provided for potential future chiller installation. All dual temperature piping to classroom fan coil units shall be sized for potential future chilled water use.
- Alternate M2 – Delete DX cooling capability for the two classroom ventilation units. Units shall be hot water heating only with energy recovery wheels.

<u>D40: FIRE PROTECTION SYSTEMS</u>

D4010 – General Requirements

- Scope includes demolition of the existing fire hose cabinets and service piping in the corridors.
- New work includes a new combination wet standpipe and sprinkler system.
- The system will be re-fed from the existing 6 inch fire service and backflow preventer.
- A new wet alarm check valve will be provided.
- The status of the existing fire department connection will be reviewed with the fire department.
- Quick response sprinkler heads will be provided throughout.
- Head layouts and hydraulic calculations will be in accordance with NFPA hazard criteria.
- Design team review of updated hydrant flow test results are necessary to confirm whether a fire pump is required.

- Work shall be performed using MA Code "Method "B" Shared Design" process.
- Work shall be performed in accordance with the MA Building Code, NFPA and the Local Authority.
- Work shall be performed by Contractors who are licensed to practice in the State.
- File and pay for all permits, fees, certificates, inspections and approvals.
- Submit Fire Protection Working Drawings, hydraulic calculations and shop drawings of all equipment and devices for approval.
- Equipment and materials shall be new, high grade commercial quality, and installed in accordance with the MA Building Code, NFPA, the local Fire Department and the Contract Documents.

D4010 – Fire Protection Sprinkler Systems

- Extension of the existing 6 inch fire service to new devices, risers and sprinkler heads.
- Sprinkler zone control assemblies in the central stair.
- Sprinkler mains and branch lines to feed sprinkler heads.
- Hydraulically calculated remote areas.
- Recessed sprinkler heads in areas with ceilings.
- Upright heads with cage guards in areas without ceilings.
- High temperature heads in the Kitchen.
- Design criteria: Hydraulically calculated to provide for the minimum required water densities over the hydraulically most demanding area.
- Submission for review by the Engineer of Record prior to fabrication of materials.
- Outside hose allowances required including a 10 psi cushion for non-ideal distribution of water in the system.
- Design densities: Light Hazard at 0.10GPM over 1,500 SF (classroom, office and general areas) and Ordinary Hazard Group I areas at 0.15 GPM over 1,500SF ( mechanical, storage and Kitchen areas.
- The NFPA 40% reduction in the most remote area is not allowed, the minimum design area for any system shall be 1,500 SF.

D4020 – Standpipe Systems

- Wet standpipe system in egress stairs and horizontal exits.

- Fire Department valves at floor landings, cabinets to be determined.
- Sprinkler zone control assemblies in the central stair.
- Design criteria: Hydraulically calculated according to the Massachusetts State Building Code, CMR-780, Eighth Edition.
- Satisfy minimum pressure requirements for the flowing standpipe hose valves.
- Verify NFPA-14, Standpipe Systems criteria of 100 psi at the outlet of remote hose valves utilizing the Local Authority's apparatus.

D4030 – Fire Protection Specialties

- Test existing double check valve and supervised valves.
- Test existing building fire department connection.
- Provide new wet alarm check valve, zone control valves, piping, hangers, sprinkler heads and accessories.
- Provide new sprinkler system drains and drain valves.
- Provide new flow, pressure and supervisory switches.
- Provide Inspector's test assemblies and miscellaneous items.
- Include preparation and submittal of complete Fire Protection Working Drawings and hydraulic calculations to the Engineer, through the Architect, for review.
- Provide shop and record drawings.
- Provide Owner and Maintenance Manuals.
- Provide testing of all piping systems, devices and alarms.
- Provide sleeves, escutcheons, hangers and miscellaneous steel supports, including seismic restraints.
- Include drilling for installation of inserts.
- Provide pipe and equipment identification.
- Provide scaffolding, hoisting and rigging.
- Provide coordination drawings.
- Provide sprinkler heads.
- Provide pressure gauges.

- Provide pressure, flow and supervisory switches.
- Fire Department valves and cabinets (if required).
- Include system and equipment start-ups; Owner instructions.
- Include seismic expansion loops.
- Pipe Materials:
  - Piping at service entry - Schedule 40, flanged or grooved.
  - Piping subject to drying and rewetting - Schedule 40, galvanized, screwed.
  - Piping 2 inch and smaller - Schedule 40, threaded.
  - Piping above 2 inch - Schedule 10, mechanical couplings, roll grooved.
- Manufacturers:
  - Piping: Berger, Allied, US Steel.
  - Fittings: Victaulic, Gustin Bacon, ITT Grinnell.
  - Alarm Valves: Viking, Reliable, Automatic Sprinkler.
  - Valves: Jenkins, Milwaukee, Kennedy.
  - Sprinkler Heads and Miscellaneous Accessories: Reliable, Viking, Gem.
  - Fire Department valves, trim, siamese, switches: Potter-Roemer, Elkhart.
  - Fire Department connections: Potter Roemer.
  - Seismic expansion loops: Metraflex

D4090 – Other Fire Protection Systems

- Related Work in Other Sections.
- Cutting and patching.
- Installation of access panels in ceilings and wall construction.
- Painting.
- Electric power and alarm wiring.
- Fire extinguishers and cabinets.
- Kitchen hood fire suppression systems.

- Sprinkler waste outlets.

End of Document

# SECTION 260500

# COMMON WORK RESULTS FOR ELECTRICAL

Filed Sub-Bids Required

## Scope

1. Electrical equipment coordination, sleeves and sleeve seals for raceways and cables, and common electrical installation requirements.

## Materials

1. Sleeves for Raceways and Cables:
   a. Steel pipe sleeves.
   b. Cast-iron pipe sleeves.
   c. Sleeves for rectangular openings.
2. Sleeve Seals: Modular sealing devices with EPDM sealing elements, carbon-steel pressure plates, and carbon-steel connecting bolts and nuts.

SECTION 260501

ELECTRICAL DEMOLITION

Filed Sub-Bids Required

Scope

1. Make safe and disconnect power to the electrical equipment scheduled to be demolished and removed by the General Contractor.

Materials

1. Provide all materials necessary for work.

# SECTION 260519

# ELECTRICAL POWER CONDUCTORS AND CABLES

Filed Sub-Bids Required

## Summary

1. Building wires, cables, connectors, splices, and terminations for wiring systems rated 600 V and less; and sleeves and sleeve seals for cables.

## Materials

1. Conductors and Cables:
    a. Conductors: Copper.
    b. Conductor Insulation: Types THHN-THWN and XHHW.
    c. Multiconductor Cable: Metal-clad cable, Type MC; Mineral-insulated, metal-sheathed cable, Type MI with ground wire.
2. Connectors and Splices: Factory fabricated.
3. Sleeves for Raceways and Cables:
    a. Steel pipe sleeves.
    b. Cast-iron pipe sleeves.
    c. Sleeves for rectangular openings.
4. Sleeve Seals: EPDM sealing elements, carbon-steel pressure plates, and carbon-steel connecting bolts and nuts.

## Conductor Material Applications

1. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

## Conductor And Insulation Applications

1. Service Entrance: Type XHHW, single conductors in raceway.
2. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
3. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

4. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

5. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

6. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

7. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

8. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

9. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

10. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

11. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway.

12. Feeders for Emergency Life Safety Systems: Type MI cable unless protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency wiring circuits or be encased in a minimum of 50mm (2 in.) of concrete.

13. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

14. Class 1 Control Circuits: Type THHN-THWN, in raceway.

15. Class 2 Control Circuits: Type THHN-THWN, in raceway; Metal-clad cable, Type MC.

Field Quality Control

1. Testing: By Contractor.

2. Infrared Scanning: For each splice in cables and conductors No. 3 AWG and larger.

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

Filed Sub-Bids Required

Summary

1. Methods and materials for grounding electrical systems and equipment.

Materials

1. Insulated Conductors: Copper wire and cable.
2. Bare Copper Conductors:
    a. Solid conductors.
    b. Stranded conductors.
    c. Tinned conductors.
    d. Stranded bonding conductors.
    e. Copper tape braided bonding jumpers.
    f. Tinned-copper braided bonding jumpers.
3. Connectors: Bolted and exothermic-welded type.
4. Grounding Electrodes:
    a. Ground Rods: Copper-clad steel.

Grounding Applications

1. Conductors: Solid for No. 8 AWG and smaller; stranded for No.6 AWG and larger.
2. Underground Grounding Conductors: Bare copper conductor, No. 2/0 AWG minimum.
3. Isolated grounding conductors.
4. Grounding bus.
5. Conductor Terminations and Connections: welded.
6. Overhead lines.
7. Underground distribution systems.
8. Insulated equipment grounding conductors with circuit conductors for the following:

a. Feeders and branch circuits.
b. Lighting circuits.
c. Receptacle circuits.
d. Single-phase motor and appliance branch circuits.
e. Three-phase motor and appliance branch circuits.
f. Flexible raceway runs.
g. Armored and metal-clad cable runs.
h. Busway supply circuits.
i. Computer- and rack-mounted electronic equipment circuits.
j. X-ray equipment circuits.
k. Air-duct equipment circuits.
l. Water heater, heat-tracing, and antifrost heating cables.
m. Isolated grounding receptacle circuits.
n. Isolated equipment enclosure circuits.

9. Signal and communication equipment.

10. Service and central equipment locations and wiring closets.

11. Terminal cabinets.

12. Metal poles supporting outdoor lighting fixtures.

Field Quality Control

1. Ground Resistance Testing: Contractor.

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

Filed Sub-Bids Required

Scope

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

Performance Requirements

1. Rated Strength: Minimum structural safety factor of five times the applied force.

Materials

1. Support, Anchorage, and Attachment Components:

    a. Steel slotted support systems with metallic coatings.

    b. Nonmetallic slotted support systems.

    c. Raceway and cable supports.

    d. Steel conduit and cable hangers, clamps, and associated accessories.

    e. Support for non-armored conductors and cables in vertical conduit risers.

    f. Structural steel for fabricated supports and restraints.

    g. Mounting, Anchoring, and Attachment Components:
        1) Powder-actuated fasteners.
        2) Mechanical-expansion anchors.
        3) Concrete inserts.
        4) Clamps for attachment to steel structural elements.
        5) All steel, springhead toggle bolts.
        6) Threaded hanger rods.

2. Fabricated Metal Equipment Support Assemblies: Welded or bolted steel shapes.

3. Concrete Bases: 3000-psi (20.7-MPa) 28-day compressive-strength concrete.

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

Filed Sub-Bids Required

Scope

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

Materials

1. Metal Conduit and Tubing:
   a. Conduit: Rigid steel.
   b. EMT.
   c. FMC: Zinc-coated steel.
   d. LFMC.
2. Nonmetallic Conduit and Tubing: ENT, RNC and LFNC.
3. Optical Fiber/Communications Cable Raceway and Fittings: Plenum type.
4. Metal Wireways: Sheet metal, NEMA Type 1 (interior) 3R (exterior).
   a. Wireway Covers: Hinged type.
5. Nonmetallic Wireways: PVC plastic.
6. Surface Raceways: Metal, galvanized steel.
7. Boxes, Enclosures, and Cabinets:
   a. Outlet and Device Boxes: Sheet metal.
   b. Floor Boxes: Cast metal; Sheet metal; Nonmetallic.
   c. Pull and Junction Boxes: Sheet metal.
   d. Hinged-Cover Enclosures: Metal.
   e. Cabinets: Galvanized steel.
8. Handholes and Boxes for Exterior Underground Wiring: Polymer concrete prototype tested for compliance with SCTE 77.
9. Sleeves for Raceways: Steel pipe.
10. Sleeve Seals: EPDM sealing element.

Installation

1. Raceway Applications:
   a. Outdoors:
      1) Exposed: Rigid steel.
      2) Concealed, Aboveground: Rigid steel; EMT.
      3) Underground: RNC, Type EPC-40-PVC, direct buried.
      4) Connection to Vibrating Equipment: LFNC.
      5) Boxes and Enclosures, Aboveground: NEMA Type 3R.
      6) Underground Handholes and Boxes: SCTE tier 15 structural load rating.
   b. Indoors:
      1) Exposed: EMT.
      2) Exposed and Subject to Severe Damage: Rigid steel.
      3) Concealed: EMT.
      4) Connection to Vibrating Equipment: FMC, except LFMC in damp or wet locations.
      5) Damp or Wet Locations: Rigid steel.
      6) Raceways for Distribution of Optical Fiber or Communications Cable: Optical fiber/communications cable raceway.
      7) Boxes and Enclosures: NEMA Type 1, except Type 4 in damp or wet locations.

SECTION 260548

VIBRATION & SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

Filed Sub-Bids Required

Scope

1. Section includes:
   a. Isolation pads.
   b. Spring isolators.
   c. Restrained spring isolators.
   d. Channel support systems.
   e. Restraint cables.
   f. Hanger rod stiffeners.
   g. Anchorage bushings and washers.

Performance Requirements

1. Seismic-Restraint Loading:
   a. Site Class as Defined in the IBC.
   b. Assigned Seismic Use Group or Building Category as Defined in the IBC.
   c. Design Spectral Response Acceleration at Short Periods (0.2 Second).
   d. Design Spectral Response Acceleration at 1.0-Second Period.

Materials

1. Vibration Isolators:
   a. Neoprene pads.
   b. Spring isolators.
   c. Restrained spring isolators.
2. Seismic-Restraint Devices:
   a. Channel support systems.
   b. Stainless-steel restraint cables.
   c. Steel tube or steel slotted-support-system sleeve with internally bolted connections and/or reinforcing steel angle clamped hanger rod stiffeners.
   d. Bushings for floor-mounted equipment anchors.
   e. Bushing assemblies for wall-mounted equipment anchorage.
   f. Resilient isolation washers and bushings.

g. Mechanical anchors.

h. Adhesive anchors.

3. Factory Finishes: Standard

Field Quality Control

1. Testing: By Contractor.

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

Filed Sub-Bids Required

Scope

1. Electrical Identification Materials and Devices:
    a. Identification for raceway and metal-clad cable.
    b. Identification for conductors and communication and control cable.
    c. Underground-line warning tape.
    d. Warning labels and signs.
    e. Instruction signs.
    f. Equipment identification labels.
    g. Miscellaneous identification products.

Materials

1. Raceway and Metal-Clad Cable Identification: Adhesive labels.
2. Conductor and Cable Identification: Marker tape.
3. Equipment Labels: Printed adhesive film with clear protective overlay.
4. Warning Signs: Baked enamel.
5. Instruction Signs: Engraved, laminated acrylic or melamine plastic.

SECTION 260573

POWER SYSTEM STUDY

Filed Sub-Bids Required

STUDY REPORT

1. Project description, purpose, basis and scope of the study.

2. Fault current calculations.

3. Arc flash calculations.

4. Selective coordination report.

5. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding the same.

6. Copies of manufacturer's time-current curves for the devices studied.

7. Protective device time versus current coordination curves.

SECTION 260913

ELECTRICAL POWER MONITORING AND CONTROL

Filed Sub-Bids Required

Scope

1. Monitoring of electrical power circuits through PC-based workstation(s) and software.

2. Monitoring of electrical power circuits through communication network and interface modules for RS-232, RS-485 Modbus, TCP/IP, IEEE 802.3 data transport protocols.

Functional Description

1. Monitor and record load profiles and chart energy consumption patterns for electricity.

2. Calculate allocation of utility costs.

3. Identify power system anomalies and measure, display, and record trends and alarms.

4. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources.

5. Manage demand.

6. Report equipment status and power system control.

7. Operating System:
   a. Software: Configured to run on a portable laptop computer, a single PC, or a palm computer.
   b. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously.
   c. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously.
   d. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously; includes interactive graphics client; Web enabled.
   e. Operating System: Based on Microsoft Windows workstation operating system.
   f. Peer computer control software to detect failure of workstation and associated server.

8. Applications Software:
   a. Password protected to three levels.
   b. Automatic and encrypted backups for database and history; automatically stored on central control PC.
   c. Operator audit trail.
   d. Workstation server functions to support other client PCs on the LAN and WAN.

e. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications.

f. Metered values displayed in real time.

g. Remote control display of circuit-breaker status and control; and user-defined schemes for load shedding automatically initiated and executed.

h. Interactive color graphic platform.

i. User-defined monitoring and event control.

j. Trending reports.

k. Alarm messages displayed and recorded.

l. Waveform data displayed and recorded.

m. Data sharing to third-party applications software.

n. Tenant or activity billing software.

o. Current alarm, supervisory, and trouble conditions reporting.

Components

1. Power Monitors:

a. Rms real-time measurements.

b. Demand current calculations, per phase, three-phase average and neutral.

c. Demand real power calculations, three-phase total.

d. Demand reactive power calculations, three-phase total.

e. Demand apparent power calculations, three-phase total.

f. Average power factor calculations, demand coincident, three-phase total.

g. Power analysis values.

h. Power demand calculations.

i. Current and voltage sampling.

j. Monthly minimum and maximum values recording.

k. Harmonic calculations display and recording.

l. Current and voltage ratings.

m. Waveform capture.

n. One digital input signal(s).

o. Outputs.

p. Onboard data logging.

q. Alarms.

r. Power monitoring communications permanently connected to Modbus TCP via a 100 Base-T Ethernet, RS-485 Modbus TCP/IP.

s. Backlighted LCD display monitors with touch-pad selecting devices.

2. Standalone, Web-Enabled Monitoring and Control Instrument:
   a. Environmental Conditions:
      1) Indoor installation in non-air-conditioned spaces.
      2) Ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing.
   b. Web-enabled power distribution equipment monitor.
   c. LAN connectivity.
   d. Factory-addressed and -tested communication devices within equipment.
   e. Server configurations for initial network parameters set using Web browser; factory-programmed network server with embedded html-formatted Web pages, password-protected login, and firewall-protected operating software.
   f. Network accessible data.
   g. Equipment monitoring options.
   h. Power monitoring communications permanently connected to RS-485 Modbus TCP/IP, Modbus TCP via a 100 Base-T Ethernet.
3. Workstation Hardware:
   a. Environmental Conditions:
      1) Indoor installation in non-air-conditioned spaces.
      2) Ambient conditions of [36 to 122 deg F (2 to 50 deg C)] dry bulb and 20 to 90 percent relative humidity, noncondensing.
   b. Computer: Standard unmodified PC.
4. RS-232 ASCII interface with pager and alarm system interface.
5. LAN Cables:
   a. RS-485 cable.
   b. Unshielded twisted pair cable.

Cabling

1. Wiring Method: In raceways except in accessible ceiling spaces or gypsum board partitions.

Field Quality Control

1. Testing: By Contractor.

SECTION 260923

LIGHTING CONTROL DEVICES

Filed Sub-Bids Required

PRODUCTS

1. Time Switches: Electronic, solid-state programmable units with alphanumeric display.

2. Outdoor Photoelectric Switches: Solid state, with dry contacts, 15-second time delay, and metal-oxide arrestor surge protection.

3. Indoor Occupancy Sensors: PIR, Ultrasonic and Dual-technology type, solid-state units with separate, externally mounted relay unit.

4. Outdoor Motion Sensors: Lighting fixture and individually mounted for operation in temperatures from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C).

5. Lighting Contactors: Electrically operated and electrically held, with fusible switch.

6. Emergency Shunt Relay: Normally closed, electrically held, arranged for wiring in parallel with manual or automatic switching contacts.

7. Control Cables:

    a. Power Cables: Not smaller than No. 12 AWG.

    b. Classes 2 and 3 Control Cables: Stranded-copper conductors, not smaller than No. 18 AWG.

    c. Class 1 Control Cables: Stranded-copper conductors, not smaller than No. 14 AWG.

SECTION 260943

NETWORK LIGHTING CONTROLS

Filed Sub-Bids Required

## SUMMARY

1. Manually operated lighting controls with relays control module.

2. Manually operated, digital lighting controls with external signal source, relays and control module.

3. Individually addressable lighting control devices communicating with data-entry and -retrieval devices using DALI protocol.

## QUALITY ASSURANCE

1. Quality Standard: 47 CFR, Subparts A and B, Class A; and IEC 60929, Annex E.

## PRODUCTS

1. Expandability: Capable of increasing capacity by 25 percent of current capacity.

2. Performance Requirements: Manual operation of switches signals relays through programmable control module.

3. Performance Requirements: Manual operation, internal timing and control unit, or an external source signals relays through programmable control module.

4. Performance Requirements: Individually addressable devices communicating with data-entry and -retrieval devices using DALI protocol.

5. Control Module: Microprocessor-based, solid-state, 365-day timing and control unit; pilot-duty, relay-type output circuits; integral keypad and alphanumeric LCD or LED display.

6. Control Module: Microprocessor-based, solid-state, 365-day timing and control unit; pilot-duty, relay-type output circuits; integral keypad and alphanumeric LCD display.

7. Control Module: Microprocessor-based, solid-state, 365-day control unit that receives programming from hand-held programmer; pilot-duty, relay-type output circuits; and integral keypad.

8. Control Module: Panelboard-mounted, microprocessor-based, solid-state, 365-day control unit; and branch circuit breakers as power-circuit switching devices.

9. Control Module: Programmable, microprocessor-based control unit mounted in preassembled modular relay panel; and lighting circuit relays as output circuit devices.

10. Control Module: Programmable, PC-based control unit with keyboard and color LCD for separate graphic display(s) for programming lighting control panelboard; interoperable with building automation system.

11. Features:

    a. Interoperability: RS 485, LonWorks or BACnet.
    b. Nonvolatile system memory.
    c. Lighting control software.
    d. Automatic time adjustment.
    e. Astronomic control.
    f. Demand control.
    g. On-off confirmation signal.
    h. Remote communication capability.
    i. Telephone override capability.
    j. Local override capability.
    k. Automatic control of local override.
    l. Automatic battery backup.
    m. Programmed time signal.
    n. Daylight balancing dimming control.
    o. Daylight compensating switch control.
    p. Bilevel controls.
    q. Flick warning.
    r. Diagnostics.
    s. Local data-entry devices: PCs, PDAs, hand-held IR devices, and wired or wireless Ethernet hubs.

12. Power Distribution Components: Modular relay panel and line-voltage surge suppression.

13. DALI Materials: One, full-rated network and lighting control software.

14. Manual Switches: Momentary contact, low-voltage push buttons and maintained contact, full- or low-voltage switches, with integral pilot light; finish plates and legends.

15. Conductors and Cables:

    a. No. 12 AWG power wiring to supply side of Class 2 power source.
    b. Classes 2 and 3 Control Cable: Multiconductor cable with copper conductors.
    c. Class 1 Control Cable: Multiconductor cable with copper conductors.
    d. Digital and Multiplexed Signal Wire: Unshielded, Category 6 twisted-pair cable.

SECTION 262416

PANELBOARDS

Filed Sub-Bids Required

MATERIALS

1. General Requirements for Panelboards:

   a. Constructed to withstand seismic forces.

   b. Enclosures: Flush and surface mounted.
      1) Indoor Dry and Clean Locations: NEMA 250, Type 1.
      2) Outdoor Locations: NEMA 250, Type 3R.

   c. Front: Secured to box with concealed trim clamps.

   d. Directory card.

   e. Incoming Mains Location: Top and bottom.

   f. Phase, Neutral, and Ground Buses: Copper.

   g. Conductor Connectors Mechanical-type main and neutral lugs.

   h. Service equipment label for panelboards incorporating one or more main service disconnecting and overcurrent protective devices.

   i. Panelboard Short-Circuit Current Rating: Rated for NRTL labeled series-connected system with integral or remote upstream overcurrent protective devices.

2. Distribution Panelboards:

   a. Mains: See drawings.

   b. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

   c. Fused switches.

   d. Contactors in Main Bus: NEMA ICS 2, Class A, with control-power transformer control-power source.

   e. Electric Meter: the main electrical service shall incorporate a Square D Powerlogic electric metering system. This system shall include revenue grade current transformers and potential transformers. The metering system shall include a Square D, Ethernet gateway to allow the electric meter to be connected to the campus's local area network. The contractor is responsible to supply and install all this hardware. The minimum meter for any new building shall be a Square D PM850. Any other lower level meters shall be approved by in writing by the Physical Plant Utilities Department.

3. Lighting and Appliance Branch-Circuit Panelboards:

   a. Mains: See drawings.

   b. Branch Overcurrent Protective Devices: Bolt-on circuit-breaker type.

c. Contactors in Main Bus: NEMA ICS 2, Class A, with control-power transformer control-power source.

4. Electronic Grade Panelboards: Integrally mounted, wired-in -style, solid-state, parallel-connected, modular sine-wave tracking, suppression and filtering module, surge protective devices (SPDs).

a. Panelboard Suppressors: Integrally mounted, wired-in, solid-state, parallel-connected, modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating.

5. Disconnecting and Overcurrent Protective Devices:

a. Molded-Case Circuit Breaker: Interrupting capacity to meet available fault currents.
1) Circuit Breakers: Thermal-magnetic types.
2) Lugs: Mechanical style.
3) Appropriate for Application: Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
4) Ground-Fault Protection: Integrally mounted relay and trip unit.
5) Communication Capability: Universal-mounted communication module.
6) Shunt Trip: 120-V trip coil.
7) Undervoltage Trip: With field-adjustable 0.1- to 0.6-second time delay.
8) Auxiliary Contacts: Two SPDT switches.
9) Key interlock kit.
10) Zone-selective interlocking.
11) Handle padlocking devices and clamps.

b. Fused Switch: NEMA KS 1, Type HD.
1) Auxiliary contacts.

FIELD QUALITY CONTROL

1. Testing: By Contractor.

2. Tests: Infrared scanning.

SECTION 262726

WIRING DEVICES

Filed Sub-Bids Required

MATERIALS

1. Receptacles: Duplex, 125 V, 20 A.
    a. Straight Blade: Weather resistant and tamper resistant.
    b. GFCI: Feed.
    c. Hazardous (classified) location receptacles.
2. Cord and plug sets.
3. Snap Switches: 120/277 V, 20 A.
    a. Pilot light switches.
    b. Key-operated switches.
    c. Single-pole, double-throw, momentary contact, center-off switches.
    d. Key-operated, single-pole, double-throw, momentary contact, center-off switches.
4. Wall Plates:
    a. Material for Finished Spaces: Thermoplastic.
    b. Material for Unfinished Spaces: Galvanized steel.
    c. Material for Damp and Wet Locations: Thermoplastic.
5. Floor Service Fittings: Modular, dual service, with power receptacle and voice and data communication outlet.
    a. Type: Flush.
    b. Service Plate: Round.
    c. Voice and Data Communication Outlet: Modular, keyed, RJ-45.
6. Poke-Through Assemblies: Below-floor junction box with multichanneled, through-floor raceway/firestop and detachable floor service outlet assembly.
    a. Service Outlet Assembly: Flush type.
    b. Size 4 inch (100 mm).
7. Multioutlet Assemblies: PVC raceways.
8. Finishes:
    a. Connected to Normal Power System: Color by Architect.

SECTION 262813

FUSES

Filed Sub-Bids Required

Scope

1. Cartridge fuses rated 600 V and less for use in controllers and motor-control centers.
2. Spare-fuse cabinets.

Materials

1. Cartridge Fuses: Nonrenewable.
2. Spare-Fuse Cabinet: Wall-mounted steel unit with fuse pullers for each size of fuse.
3. Fuse Applications:
   a. Motor Branch Circuits: Class RK1/RK5, time delay.

SECTION 264113

LIGHTNING PROTECTION FOR STRUCTURES

Filed Sub-Bids Required

Scope

1. Lightning protection for buildings.

Quality Assurance

1. Installer: NRTL listed or certified by LPI as Master Installer/Designer.
2. Quality Standards: NFPA 780, UL 96, and UL 96A.

Materials

1. Roof-Mounting Air Terminals: Copper; solid.
2. Ground rods.

Installation

1. Installation Standards: UL 96A and NFPA 780.
2. Conductors to be Concealed:
    a. System conductors.
    b. Down conductors.
    c. Interior conductors.
    d. Conductors within normal view from exterior locations at grade.
3. Cable Connections: Exothermic.
4. Counterpoise as ground loop.
5. Lightning protection components bonded with intermediate-level interconnection loop conductors at 60-foot (18-m) intervals.

Field Quality Control

1. Inspection: UL Master Label.

# SECTION 265100

# INTERIOR LIGHTING

Filed Sub-Bids Required

## Scope

1. Interior lighting fixtures.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

## Materials

1. LED Light Fixtures
   a. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
   b. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
   c. LED drivers shall include the following features unless otherwise indicated:
   d. Minimum efficiency: 85% at full load.
   e. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
   f. Input Voltage: 120 - 277V (±10%) at 60 Hz.
   g. Integral short circuit, open circuit, and overload protection.
   h. Power Factor: ≥ 0.95.
   i. Total Harmonic Distortion: ≤ 20%.
   j. Comply with FCC 47 CFR Part 15.
   k. LED modules shall include the following features unless otherwise indicated:
   l. Comply with IES LM-79 and LM-80 requirements.
   m. Minimum CRI 85 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
   n. Minimum Rated Life: 50,000 hours per IES L70.
   o. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

SECTION 265600

EXTERIOR LIGHTING

Filed Sub-Bids Required

Scope

1. Exterior luminaires with lamps and ballasts, luminaire-mounted photoelectric relays, poles and accessories, and luminaire lowering devices.

2. Section does not include exterior luminaires mounted on exterior of building.

Materials

1. LED Luminaires
   a. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
   b. Material and specifications for each luminaire are as follows:
      1) Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
      2) Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night at 40ºC (104ºF).
      3) Reported lumen maintenance shall be greater than 90% per TM-21-11 after 60,000 hours of luminaire operation in an ambient environment from 15ºC (59ºF) to 40ºC (104ºF).
      4) The rated operating temperature range shall be -35°C (-31ºF) to +40°C (104ºF).
      5) Each luminaire is capable of operating above 104°F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
      6) Photometry must be compliant with IESNA LM-79.
      7) Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime temperature.
      8) The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
      9) Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
      10) Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.

2. Luminaire Support Components
   a. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

   b. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

1) Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

c. Manufacture: Appurtenance, arm, bracket, and tenon mount materials shall be as manufactured for the luminaire required.

d. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1) Materials: Will not cause galvanic action at contact points.
2) Mountings: Correctly position luminaire to provide indicated light distribution.

3. Installation

a. Raceways: All circuitry shall be in raceways with hand-holes for future access, direct buried cable is not acceptable.
1) Raceways: Raceways shall be installed for all circuitry with one additional spare conduit of equal size. At hand-holes conduits shall be stubbed up with sweeps. No continuous conduit run shall have more than 270 degrees of bends. Raceways shall not be filled in excess of 50% of their fill capacity.
2) Hand-holes: Hand-holes shall be installed at each lighting unit and at intervals not greater than 100 feet. Hand-holes shall be located no closer than 12” from edge of hand-hole to edge of pole and no greater than 24” from edge of hand-hole to edge of pole. Hand-holes shall be installed flush with finished grade.

b. Circuitry: all circuitry shall be contactor controlled at one central location with one photo-cell rated for contactor, and with a test switch to by-pass photo-cell for testing. Circuits shall be arranged so that in the event that a circuit is lost only every third Luminaire will be de-energized.
1) Conductors shall be color coded along their continuous length and circuit numbers shall be marked at all accessible locations with numbers suitable for the location. For 480/277 circuits (Brown, Orange, Yellow, Gray), for 208 circuits (Black, Red, Blue) and grounds Green; 120 volts not allowed.
2) An equipment grounding conductor shall be installed with all circuits.
3) No circuit overcurrent device shall be rated greater than twenty amps. Circuits shall not be loaded greater that 12 amps with a maximum voltage drop of 3% at furthest luminaire.
4) All contactors shall have 25% spare capacity for future expansion.
5) Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
6) Nonmetallic Poles: Ground metallic components of lighting units and foundations. Connect luminaires to grounding system with No. 6 AWG conductor.
7) Run all three circuits or more if required in that run to the last hand hole of every circuit group.

c. Luminaire: Install luminaires at intervals and wattages as follows:
1) Roadway Lighting Standards: Spacing: 80’ on center, Light level: IEEE: Roadway Collector (serving traffic between major and local roadways); Lux - 13, Footcandles - 1.2. Local (direct access to residential, commercial or abutting property; Lux - 10, Footcandles - 0.9. (Average Maintained Illuminance on the Horizontal).
2) Traffic Conflict Areas, intersections and pedestrian crosswalks shall be illuminated at least 150% of the average route value.
3) SIDEWALKS LIGHTS (roadside): Spacing: 80’ on center cut-off and/or 60’ on center King Luminaire. Luminaire and spacing depend on the ability of the roadway lighting to

establish footcandle levels required, ie; side of the road, trees between walk and roadway e.t.c. Light level: IEEE: Intermediate areas (Moderately heavy night-time pedestrian activity). Minimum Average Levels; Lux - 6, Footcandles - 0.6. (Average Maintained Illuminance on the Horizontal).

4) WALKWAY LIGHTS (distant from roadways): Spacing: 60’ on center Light level: IEEE: Minimum Average Levels Park walkways and bikeways; Lux - 5, Footcandles - 0.5. Pedestrian stairways; Lux - 6, Footcandles - 0.6. (Average Maintained Illuminance on the Horizontal).
5) PARKING LOT LIGHTS: Arms: 2’, Single or double depending on layout. Spacing: 116’ in lot (every other row), 117 or 126’ in rows depending on layout, poles must be between spacing. Light level: IEEE: Educational facility parking (Low Activity). Vehicular Traffic; Lux - 5, Footcandles - 0.5, Uniformity Ratio - 4:1 Pedestrian Safety & Security; Lux - 9, Footcandles - 0.8, Uniformity Ratio - 5:1 (Average to Minimum Illuminance).
6) These levels represent average Illuminance when the luminaires are at their lowest output. Since Illuminance values depreciate as much as 50% or more, IEEE (LLD) lamp lumen depreciation and (LDD) luminaire dirt depreciation factors must be used in designs. In addition to these requirements all other IES recommendation shall be followed.
7) Luminaire Attachment: Fasten to indicated structural supports.
8) Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.
9) Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

4. Field Quality Control

a. Inspect each installed unit for damage. Replace damaged units.

b. Advance Notice: Give dates and times for field tests.

c. Provide instruments to make and record test results.

d. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:
1) Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.
2) Check intensity and uniformity of illumination.
3) Check excessively noisy ballasts.

e. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

f. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

5. Cleaning and Adjusting

a. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

b. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

SECTION 271100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

Filed Sub-Bids Required

Scope

1. Telecommunications mounting equipment, service entrance pathways, and grounding.

Materials

1. Cable Supports: Fire-resistant support brackets, lacing bars, spools, J-hooks, and D-rings.
2. Cable Trays: Metal, electroplated zinc galvanizing or hot-dip galvanizing.
    a. Basket cable trays.
    b. Trough cable trays.
    c. Ladder cable trays.
    d. Channel cable trays.
    e. Solid-bottom cable trays.
3. Backboards: Plywood, fire-retardant.
4. Equipment Frames: Steel or aluminum.
    a. Floor-mounted racks.
    b. Modular freestanding cabinets.
    c. Modular wall cabinets.
5. Power Strips: 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles; cord connected with 15-foot (4.5-m)] line cord; and 33kA peak single-impulse surge current rating per phase.
6. Grounding Connectors: Solderless exothermic type.
7. Labeling: Comply with TIA/EIA-606-A and UL 969.

SECTION 271300

COMMUNICATIONS BACKBONE CABLING

Filed Sub-Bids Required

Performance Requirements

1. Cabling Standards: TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3,

Materials

1. Cabling
   a. UTP Cabling: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.
      1) Provide 50-pair Category 3 copper backbone cable from the Goodell building via manholes 72A and 65F to a demarc in the basement of the Chapel.
   b. Optical Fiber Cabling: Single mode, 8.3/125- micrometer and multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer.
      1) Provide 12-strands of single mode and 12-strands of multimode optical fiber cable from the Goodell building via manholes 72A and 65F to a demarc in the basement of the Chapel.
   c. Coaxial Cabling: 750 Series hardline cable optimized for use in broadband distribution plants.
      1) Provide 2 750 hardline coaxial cables from the Goodell building via manholes 72A and 65F to a demarc in the basement of the Chapel.
2. Hardware
   a. Backbone connecting hardware by ADC/Tyco.

Field Quality Control

1. Testing: By Contractor.

# SECTION 271500

# COMMUNICATIONS HORIZONTAL CABLING

Filed Sub-Bids Required

## Performance Requirements

1. Cabling Standards: TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3,

## Materials

1. Cabling
   a. UTP Cabling: 100-ohm, 4-pair cable, Type CMR, Category 6.
2. Hardware
   a. UTP cable hardware by ADC/Tyco.

## Station Outlets

1. Provide one voice and two data outlets at each workstation.
2. Provide two data drops at each wireless access point location.

## Field Quality Control

1. Testing: By Contractor.

# SECTION 275319

# PUBLIC SAFETY RADIO DISTRIBUTED ANTENNA SYSTEM (DAS)

Filed Sub-Bids Required

## Scope

1. This specification describes the criteria for deploying a Public Safety Radio Distributed Antenna System (DAS) for police and fire departments. The DAS components specified in this document include: Channelized Bi-Directional Amplifiers (BDA), Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners and Couplers. These devices shall be used as part of a system, by the DAS integrator, experienced with designing projects for in-building, public safety, 2-way radio systems.

## Power Supply

1. Operating in normal (supervisory) mode, twenty-four (24) hours, followed by twelve (12) hours of emergency operation.

2. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source shall cause a change in system status.

## Alarming

1. Battery low voltage alarm

2. Loss of A.C. input power or failure of the UPS power

3. Amplifier failure

## Components

1. Yagi Donor Antennas

2. Bi-Directional Amplifier (BDA)

3. Air Dielectric, Plenum Rated Cable

4. Foam Dielectric Cable

SECTION 283111

ADDRESSABLE FIRE-ALARM SYSTEM

Filed Sub-Bids Required

Scope

1. System Description: Non-coded, addressable system with multiplexed signal transmission, dedicated to fire-alarm service only.

Systems Operational Description

1. Signal initiation from:
    a. Manual stations.
    b. Heat detectors.
    c. Flame detectors.
    d. Smoke detectors.
    e. Duct smoke detectors.
    f. Verified automatic alarm operation of smoke detectors.
    g. Automatic sprinkler system water flow.
    h. Heat detectors in elevator shaft and pit.
    i. Fire-extinguishing system operation.
    j. Fire standpipe system water flow.
2. Signal initiates the following actions:
    a. Continuously operate alarm notification appliances.
    b. Identify alarm at the fire-alarm control unit and annunciators.
    c. Transmit an alarm signal to the remote alarm receiving station.
    d. Unlock electric door locks in designated egress paths.
    e. Release fire and smoke doors held open by magnetic door holders.
    f. Activate voice/alarm communication system.
    g. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
    h. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
    i. Activate stairwell and elevator shaft pressurization systems.
    j. Close smoke dampers in air ducts of designated air conditioning duct systems.
    k. Recall elevators to recall floors.
    l. Activate emergency lighting control.
    m. Activate emergency shutoffs for gas and fuel supplies.

n. Record events in the system memory.

o. Record events by the system printer.

3. Supervisory signal initiation by:

a. Valve supervisory switch.

b. Low-air-pressure switch of a dry-pipe sprinkler system.

c. Elevator shunt-trip supervision.

4. Trouble signal initiation by:

a. Open circuits, shorts, and grounds, in designated circuits.

b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

c. Loss of primary power at fire-alarm control unit.

d. Ground or a single break in fire-alarm control unit internal circuits.

e. Abnormal ac voltage at the fire-alarm control unit.

f. Break in standby battery circuitry.

g. Failure of battery charging.

h. Abnormal position of any switch at the fire-alarm control unit or annunciator.

i. Fire-pump power failure, including a dead-phase or phase-reversal condition.

j. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

5. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and graphic annunciators. Record the event on system printer.

Materials

1. Fire-Alarm Control Unit: Modular, power-limited design with electronic modules, addressable initiation devices.

a. Alphanumeric liquid-crystal display with 3 line(s) of 80 characters and system controls and keypad.

b. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

c. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.

2. Manual Fire-Alarm Boxes: Double action.

3. System Smoke Detectors: Base mounted, self-restoring, with integral visual-indicating light and remote controllability from fire-alarm control unit.

4. Nonsystem Smoke Detectors: Single-station duct smoke detectors.

5. Heat Detectors: Combination type.

6. Notification Appliances:

a. Chimes: Low-level output.

b. Horns: Electric-vibrating-polarized type, 24-V dc.

c. Visual Alarm Devices: Xenon strobe lights.

d. Voice/Tone Speakers: Flush mounted.

7. Magnetic Door Holders: Wall- or floor-mounted units; 24-V ac or dc.

8. Remote Annunciator: Alphanumeric display same as fire-alarm control unit.

9. Addressable Interface Device: Microelectronic monitor module with integral relay to initiate elevator recall.

10. Digital Alarm Communicator Transmitter: For transmission of fire-alarm, supervisory, and trouble signals to a remote alarm receiving station or another remote location by means of telephone lines.

11. Radio Alarm Transmitter: For transmission of fire-alarm, supervisory, and trouble signals to a remote alarm receiving station or another remote location by means of radio signal.

Field Quality Control

1. Testing: By Contractor.

**Gibbs School 11-211-16**

**DIVISON 32: EXTERIOR IMPROVEMENTS**

**32 12 16 -Asphalt Paving**

1. Bituminous concrete roadway pavement shall consist of the following: 12-inch Gravel Borrow for Aggregate Base complying with Massachusetts Highway Department (MHD) Specifications Section M1.03.0 Type "B", 2-inch Type I-1 Bituminous Concrete Binder conforming to MHD Specification Section M3.11.03, and 2-inch Type I-1 Bituminous Concrete Top Course conforming to MHD Specification Section M3.11.03.
2. Vertical Granite Curb will be of Massachusetts Department of Public Works (M.D.P.W) Granite Curb. Granite Curb will have a 6-inch reveal. Granite Curb will conform to Section 500 of the MHD Specifications for Curbing and Edging.

**32 3 13-Concrete Paving**

A. Portland cement concrete for pavements and slabs shall be air-entrained type with a maximum water-cement ratio of 5.0 conforming to ACI 316R. Minimum compressive strengths at 28 days shall be as follows: Flexural strength with third point loading - 650 psi; compressive strength - 4000 psi.
B. Reinforcing bars shall consist of #4 deformed bars unless otherwise specified. The bars shall be rolled from new billet steel conforming to the requirements of ASHTO-M31, Grade 60.
C. All dimensions and thicknesses as shown on the drawings.
D. Colored concrete to include a high density integral add mixture by Scoffield or equal.

**32 13 73 -Concrete Paving Joint Sealants**

**32 17 23 -Pavement Markings**

1. Marking paint for crosswalks and lane markings shall be fast drying white traffic paint and fast drying yellow traffic paint as specified in MHD Standard Specifications under Sections M7.01.10, and M7.01.11, respectively. Work under this item shall be in conformance with Section 860 of the Standard Specifications and the Manual on Uniform Traffic Control Devices. Paint shall be applied with mechanical equipment to produce uniform straight edges, in two coats, at manufacturer's recommended rates.

**32 93 00 -Planting**

A. Furnish and install all plants as per Drawings in quantities listed on plant materials list. If there is any discrepancy between quantities listed and shrubs shown, notify the Owner's Representative. Contractor shall be responsible for quantity of shrubs graphically shown on plans.

B. All plants shall be nursery grown unless authorized to be collected.

C. Plants: in accordance with USDA Standard for Nursery Stock, latest edition, hardy under climatic conditions similar to locality of project, typical of species or variety, normal habit of growth, sound, healthy, vigorous, well-branched, densely foliated when in leaf, free of disease, insect pests, eggs, or larvae, with well-developed root systems.

**32 31 13 -Chain Link Fences and Gates**

**32 30 00 -- Site Improvements**

1. Sustainable Features – Products for site improvement will include recycled content. The products will include: bituminous pavement, base materials, fencing and site furniture.
2. Furnish and install decorative fencing including poured-in-place concrete post footings.
3. Furnish and install site benches and trash receptacles.
4. Furnish and install trash collection/ recycling receptacle enclosure.
5. Furnish and install steel and concrete bollards as required to protect utility equipment.
6. Courtyard Paving: Colored Concrete

7. Site stairs and rails and retaining walls.
8. Bollards: concrete filled steel.
9. Bike racks.
10. Decorative site lighting.
11. Temporary site perimeter fencing – 8ft high CLF w/ dust barrier

**32 16 00 -- Paving, Walkways and Curbing**

1. Sustainable Features – Paving, walks, ramps and curbing will include recycled content. Base materials for paving and walks will include recycled content.
2. Provide new bituminous and concrete paving for all new parking areas, walkways and ramps within the property.
3. Provide painted parking space striping.
4. Provide vertical granite curbing for parking areas.

# Appendix A – Supplemental Hazardous Building Materials Inspection Report With Opinion of Abatement Costs

# Supplemental Hazardous Building Materials Inspection Report

**Gibbs School**
**41 Foster Street**
**Arlington, Massachusetts**

## Finegold Alexander Architects

**Boston, Massachusetts**

**November 2016**

**Fuss & O'Neill EnviroScience, LLC**
50 Redfield Street, Suite 100
Boston, MA 02122

Project No. 20160627.A1E

FUSS & O'NEILL
EnviroScience, LLC

November 11, 2016

Ms. Regan Shields Ives, AIA, LEED AP
Senior Associate
Finegold Alexander Architects
77 North Washington Street, 7th Floor
Boston, MA 02144

**RE: Supplemental Hazardous Building Materials Inspection**
**Gibbs School**
**41 Foster Street, Arlington, Massachusetts**
Fuss & O'Neill EnviroScience, LLC No. 20160627.A1E

Dear Ms. Shields Ives:

Enclosed is the supplemental hazardous building materials inspection summary report for the inspection conducted at the Gibbs School located at 41 Foster Street in Arlington, Massachusetts.

On October 10, 2016, Fuss & O'Neill EnviroScience, LLC state-certified Asbestos Inspectors performed a limited asbestos inspection, a lead-based paint visual assessment, and a fluorescent light ballast and mercury-containing equipment inventory prior to proposed building renovation activities.

The information summarized in this report is solely for the abovementioned materials. The work was performed in accordance with our written scope of services revised September 7, 2016.

If you should have any questions regarding the contents of the enclosed report, please do not hesitate to contact me at 617-282-4675, extension 4703. Thank you for this opportunity to have served your environmental needs.

Sincerely,

Dustin A. Diedricksen
Project Manager

DD/ftc

Enclosure

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FUSS & O'NEILL
EnviroScience, LLC

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# 1 Introduction

On October 10, 2016, Fuss & O'Neill EnviroScience, LLC (EnviroScience) representatives, Mr. Jonathan Hand and Mr. Christopher McIntyre, performed a supplemental hazardous building materials inspection prior to proposed renovation activities at the Gibbs School located at 41 Foster Street in Arlington, Massachusetts (the "Site").

A hazardous materials determination survey was conducted previously at the Site by Universal Environmental Consultants, Inc. (UEC) and the report dated March 31, 2016 was utilized during this inspection. Relevant results and conclusions from these reports have been included.

## 1.1 Scope of Work

The work was performed for Finegold Alexander Architects (the "Client") in accordance with our written scope of services revised September 7, 2016. This report is subject to the limitations presented in *Appendix A*. The scope of work included the following:

- Limited Asbestos-Containing Materials (ACM) Inspection;
- Lead-Based Paint (LBP) Visual Assessment; and
- Fluorescent Light Ballast and Mercury-Containing Equipment Inventory.

Intrusive or destructive investigative techniques were not performed at the Site to access and to observe inaccessible or concealed areas that may contain suspect ACM that were hidden or obstructed from normal view (per Client's request). Hard enclosures or obstructed areas typically include, but are not limited to, the following:

- Wall Cavities;
- Pipe Chases;
- Spaces above Fixed Ceilings;
- Beneath Window/Door Frames;
- Underneath Wooden or Raised Flooring;
- Behind Mirrors, Blackboards, and Signage;
- Voids behind Brick Façade;
- Roofing Materials;
- Areas behind and within Mechanical Equipment (Including Freezers and Refrigeration Units); and
- Vapor/Moisture Barrier under Floors or on Concrete Foundations.

Several areas were not accessible during the inspection. These areas included the following:

- Former Cafeteria/Kitchen Area;
- Boiler Room;
- Library; and
- Learn to Grow Space.

EnviroScience did not conduct subsurface investigations to identify concealed suspect materials throughout the subject property.

We excluded collection and analysis of suspect materials for polychlorinated biphenyls (PCBs) during this inspection. Sampling for PCBs is presently not mandated by the United States Environmental Protection Agency (EPA); however, significant liability risk for disposing PCB-containing wastes exists. Recent knowledge of PCBs within these matrices has become more prevalent, especially with remediation contractors, waste haulers, and disposal facilities. Many property owners have become subject to large changes in schedule, scope, and costs as a result of failure to identify this possible contaminant prior to renovation or demolition activities.

## 1.2 Building Description

The Site Building includes two sections - a three-story building reportedly constructed in 1928, and a two-story addition reportedly constructed in 1973. The most recent renovation date is unknown. The building contains approximately 69,000 square feet of interior space. The original building is concrete and masonry construction on a poured concrete slab. The main portion of the school building has a built-up roofing system, and there is a membrane roofing system above the Gymnasium. Interior finishes include plaster walls/ceiling and resilient floor coverings. The addition consists of concrete masonry unit walls, a brick veneer, a membrane roofing system over the connector portion, asphaltic roof shingles over the main portion, and a poured concrete slab.

# 2 Asbestos Inspection

A property owner must ensure that a thorough asbestos inspection is performed prior to possible disturbance of suspect ACM during renovation or demolition activities. This is a requirement of the EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation located at Title 40 CFR, Part 61, Subpart M.

On October 10, 2016, Mr. Hand and Mr. McIntyre of EnviroScience conducted the limited inspection of visible, accessible areas. Mr. Hand and Mr. McIntyre are both Commonwealth of Massachusetts Department of Labor Standards (MADLS)-certified Asbestos Inspectors. Refer to *Appendix B* for copies of each Asbestos Inspector's state certification and EPA accreditation.

## 2.1 Methodology

The inspection was conducted by visually inspecting for suspect ACM and touching each of the suspect materials. The suspect materials were categorized into three EPA NESHAP groups: friable and non-friable Category I and Category II type ACM.

- A Friable Material is defined as material that contains greater than one percent (> 1%) asbestos that, when dry, **can** be crumbled, pulverized, or reduced to powder by hand pressure.
- A Category I Non-Friable Material refers to material that contains > 1% asbestos (i.e., packings, gaskets, resilient floor coverings, and asphalt roofing products) that when dry **cannot** be crumbled, pulverized, or reduced to powder by hand pressure.

- A Category II Non-Friable Material refers to any non-friable material excluding Category I materials that contain > 1% asbestos that when dry **cannot** be crumbled, pulverized, or reduced to powder by hand pressure.

The suspect ACM were also categorized into their applications including, Thermal System Insulation (TSI), Surfacing ACM, and Miscellaneous ACM. TSI includes those materials used to prevent heat loss/gain or water condensation on mechanical systems. Examples of TSI are pipe insulation, boiler insulation, duct insulation, and mudded pipe fitting insulations. Surfacing ACM includes those ACM that are applied by spray, trowel, or otherwise applied to an existing surface. Surfacing ACM is commonly used for fireproofing, decorative, and acoustical applications. Miscellaneous materials include those ACM not listed as thermal or surfacing, such as sheet flooring, floor tiles, ceiling tiles, caulking, mastics, construction adhesives, etc.

The EPA recommends collecting suspect ACM samples in a manner sufficient to determine asbestos content and to segregate each suspect type of homogenous (similar in color, texture, and date of application) materials. The EPA NESHAP regulation does not specifically identify a minimum number of samples to be collected for each homogeneous material, but the NESHAP regulation does recommend the use of sampling protocols included in EPA Title 40 CFR, Part 763, Subpart E: Asbestos Hazard Emergency Response Act (AHERA).

The EPA AHERA regulation requires a specific number of samples be collected based on the type of material and quantity present. This regulation includes the following protocol:

1. Surfacing Materials (i.e., plaster, spray-applied fireproofing, etc.) must be collected in a randomly distributed manner representing each homogenous area based on the overall quantity represented by the sampling as follows:

    a. Three samples collected from each homogenous area that is less than or equal to 1,000 square feet.
    b. Five samples collected from each homogenous area that is greater than 1,000 square feet but less than or equal to 5,000 square feet.
    c. Seven samples collected from each homogenous area that is greater than 5,000 square feet.

2. Thermal System Insulation (i.e., pipe insulations, tank insulations, etc.) must be collected in a randomly distributed manner representing each homogenous area. Three samples must be collected from each material. Also, a minimum of one sample of any patching materials applied to TSI, presuming the patched area is less than six linear or square feet, should be collected.

3. Miscellaneous Materials (i.e., floor tile, gaskets, construction mastics, etc.) should have a minimum of two samples collected for each type of homogenous material. Sample collection was conducted in a manner sufficient to determine asbestos content of the homogenous material as determined by the inspector.

Suspect ACM samples were collected and proper chain-of-custody forms were prepared for transmission of collected samples to EMSL Analytical, Inc. (EMSL) for analysis. EMSL is a Commonwealth of Massachusetts-licensed and American Industrial Hygiene Association (AIHA)-accredited Asbestos Analytical Laboratory. Initial asbestos sample analysis was conducted using the EPA Interim Method for the Determination of Asbestos in Bulk Building Materials (EPA/600/R-93/116) via Polarized Light Microscopy with Dispersion Staining (PLM/DS).

The EPA recommends that non-friable, organically-bound (NOB) materials (e.g., asphaltic-based materials, adhesives, caulking, etc.) undergo further confirmatory analysis utilizing Transmission Electron Microscopy (TEM). Three (3) of the collected NOB samples were analyzed by TEM.

## 2.2 Results

The EPA, the Occupational Safety and Health Administration (OSHA), and the MADLS, define a material that contains > 1% asbestos utilizing PLM/DS, as an ACM. The Massachusetts Department of Environmental Protection (MassDEP) further defines ACM as materials containing greater than or equal to (≥) 1% asbestos. MassDEP also defines an asbestos-containing waste material (ACWM) as:

- ACM removed during renovation or demolition activities;
- Materials contaminated by an ACM during renovation or demolition activities; or
- ACM on and/or in facility components that are inoperable or have been taken out of service.

The MassDEP further defines waste material containing any amount of asbestos as an ACWM, which must be managed and disposed as such. Materials that are identified as "none detected" are specified as not containing asbestos.

Utilizing the EPA, OSHA, MADLS, and MassDEP protocol and criteria, the following materials were determined to be either **ACM** or **ACWM**:

- Brown Stair Tread Adhesive;
- White Generator Exhaust Insulation;
- Gray Side Light Glazing Compound (Entry);
- Gray Original Window Caulking;
- Fire Door Core Insulation;
- Debris in 2nd Floor Ceiling Plenum;
- Pipe Insulation;
- Boiler Insulation;
- Brown Sink Undercoating;
- 12" x 12" Brown Mottled Floor Tile & Associated Mastic;
- Gray Exterior Sill Caulking;
- Black Veneer Dampproofing (1973 Addition);
- Partition Window Glazing Compound;
- Ceramic Floor/Wall Tile Adhesives, Grout, & Mud-Set Mortar (Assumed);
- Black Board Adhesive (Assumed);
- Roofing Materials (Assumed);
- Interior Boiler Components (Assumed);
- Incinerator (Assumed)
- Boiler Breeching Insulation (Assumed);
- Heat Exchanger Insulation (Assumed); and
- 9" x 9" Floor Tile & Associated Mastic (Assumed).

Refer to **Table 1**, attached hereto, for the complete list of ACM, ACWM, and non-ACM identified by sample identification, material type, sample location, and asbestos content as part of this inspection. Refer to **Table 2**, attached hereto, for the identified ACM inventory.

Refer to *Appendix C* for the asbestos laboratory analytical reports and chain-of-custody forms.

## 2.3 Conclusions and Recommendations

Based on visual observations, sample collection, and laboratory analysis, ACM/ACWM were identified at the Site.

Prior to disturbance, ACM/ACWM that would likely be impacted by the proposed renovation activities must first be abated by a MADLS-licensed Asbestos Abatement Contractor. This is a requirement of MADLS, MassDEP, and EPA NESHAP regulations governing asbestos abatement.

Due to the inability to effectively separate some types of multi-layered ACM (e.g., floor tile/mastic, gypsum board/joint compound, mastic/plywood, etc.) from non-ACM, these materials are considered asbestos-contaminated and must be managed as ACWM for removal and disposal purposes.

At the Client's request, hidden or inaccessible areas were not inspected as part of this inspection. Prior to renovation activities that may disturb hidden or inaccessible areas, we recommend conducting a supplemental asbestos inspection of these areas and spaces. These spaces include, but are not limited to, the following:

- Wall Cavities;
- Beneath Window/Door Frames;
- Underneath Wood or Raised Flooring;
- Behind Mirrors, Blackboards, and Signage;
- Voids behind Brick Veneer;
- Areas behind/ within Mechanical Equipment (Including Freezers and Refrigeration Units);
- Vapor/Moisture Barrier under Floors or on Concrete Foundations;
- Roof Areas;
- Adhesives behind Wall Tiles; and
- Behind Wall Coverings.

If suspect materials should be encountered during renovation activities that are not identified in this report as being non-ACM, they should be assumed to be ACM until sample collection and laboratory analysis indicate otherwise.

EnviroScience recommends that if any ACM are to remain in the building following renovation/demolition activities, the ACM should be managed in-place under a written Operations and Maintenance Program in accordance with OSHA regulations.

This report is not intended to be utilized as a bidding document or as a project specification document. The report is designed to aid the building owner, architect, construction manager, general contractors, and asbestos abatement contractors in locating ACM and ACWM.

# 3 Lead-Based Paint

On October 10, 2016, Mr. Hand and Mr. McIntyre of EnviroScience performed a visual LBP assessment associated with painted building components at the Site that may be disturbed during renovation activities.

## 3.1 Methodology

LBP issues involving properties that are not residential are only regulated to a limited degree for worker protection relating to LBP-disturbing work activities and waste disposal.

Worker protection is regulated by OSHA regulations, as well as MADLS regulations. These regulations include air monitoring of workers to determine exposure levels when disturbing lead-containing paint. A LBP visual assessment cannot determine a safe level of lead, but is intended to provide guidance for implementing industry standards for lead in paint at identified locations. Contractors may better determine worker exposure to airborne lead by understanding the different concentrations of LBP on representative components and surfaces. Air monitoring can then be performed during activities that disturb paint on representative surfaces.

The EPA Resource Conservation and Recovery Act (RCRA) and MassDEP regulate lead-containing waste disposal. If lead is determined to be present, representative composite samples of the anticipated waste stream must be collected and analyzed using the Toxicity Characteristic Leaching Procedure (TCLP). The results are compared to a threshold value of 5.0 milligrams per liter (mg/L). If TCLP sample analytical results exceed this value, the waste is characterized as hazardous lead waste. If the result is below the threshold value, the waste material is not considered hazardous and may be disposed as construction and demolition debris.

A level of paint exceeding 1.0 milligram of lead per square centimeter ($mg/cm^2$) of surface area is considered toxic or dangerous by EPA and the Massachusetts Department of Public Health (MADPH) child-occupied residential standards.

## 3.2 Results

Based on the two ages of the building and observed painted building components, LBP is likely present (at levels $\geq$ 1.0 $mg/cm^2$) at locations that may be impacted by potential renovation activities.

## 3.3 Discussion

OSHA published a Lead in Construction Standard (OSHA Lead Standard) Title 29 CFR, Part 1926.62 in May of 1993. This Standard sets no limit for the content of lead in paint below which the OSHA standards do not apply. The OSHA Lead Standards are task-based and are also based on airborne exposures and blood lead levels.

The results of this LBP visual assessment are intended to provide guidance to contractors for occupational lead exposure controls. Building components coated with lead levels above industry standards may cause exposures to lead above OSHA standards during proposed demolition/renovation activities. The results of this LBP visual assessment are also intended to provide insight into waste disposal requirements, in accordance with

EPA RCRA regulations. At the Client's request, a TCLP sample to characterize the expected waste that may result from possible selective demolition/renovation activities was not collected as part of this inspection.

## 3.4 Conclusions and Recommendations

Based on our LBP visual assessment, LBP is likely to be present on coated building components located at the Site.

Contractors must be made aware that OSHA has not established a level of lead in a material below which OSHA Title 29 CFR, Part 1926.62 does not apply. Contractors shall comply with exposure assessment criteria, interim worker protection, and other requirements of the regulation as necessary to protect workers during any renovation and/or demolition activities that will impact LBP.

If disturbed by renovation activities, LBP-coated building components should be segregated from the general demolition waste stream for sample collection and analysis by TCLP to determine proper off-site waste disposal. If disturbed and managed off-site, non-porous LBP-coated building materials (i.e., metals) may be segregated and recycled as scrap metal. Metal LBP-coated building components cannot be subject to grinding, sawing, drilling, sanding, or torch cutting.

The building is presently characterized as a commercial property, which is not subject to the MADPH Childhood Lead Poisoning Prevention Program (CLPPP) Regulation 105 CMR 460.000. The Site may be renovated using procedures required in accordance with OSHA Title 29 CFR, Part 1926.62 and MADLS Regulation 454 CMR 22.11. In addition, the building is not considered a "child-occupied facility" and therefore, is not subject to MADPH CLPPP regulations.

Note that the information contained in this report concerning the presence or absence of lead in paint, does not constitute a comprehensive lead inspection in accordance with MADPH CLPPP regulations. The screened painted surfaces represent only a portion of those surfaces that would be screened to determine whether the premises are in compliance with the aforementioned regulations, which are specific to a child-occupied residence only, and not applicable to buildings of this type and current use.

# 4 Fluorescent Light Ballasts and Mercury-Containing Equipment

## 4.1 Fluorescent Light Ballasts

Fluorescent light ballasts manufactured prior to 1979 may contain capacitors that contain PCBs. Light ballasts installed as late as 1985 may contain PCB capacitors. Fluorescent light ballasts that are not labeled as "No PCBs" must be assumed to contain PCBs unless proven otherwise by quantitative analysis. Capacitors in fluorescent light ballasts labeled as non-PCB-containing may contain diethylhexl phthalate (DEHP). DEHP was the primary substitute to replace PCBs for small capacitors in fluorescent lighting ballasts in use until 1991. DEHP is a toxic substance, a suspected carcinogen, and is listed under RCRA and the Superfund Law as a hazardous waste. Therefore, Superfund liability exists for landfilling both PCB- and DEHP-containing light ballasts. These listed materials are considered hazardous waste under RCRA and require special handling and disposal considerations.

## 4.2 Mercury-Containing Equipment

Fluorescent lamps/tubes are presumed to contain mercury vapor, which is a hazardous substance to both human health and the environment. Thermostatic controls and electrical switch gear may contain a vial or bulb of liquid mercury associated with the control. Mercury-containing equipment is regulated for proper disposal by EPA RCRA regulations.

## 4.3 Results

On October 10, 2016, Mr. Hand and Mr. McIntyre of EnviroScience performed a visual inspection of representative fluorescent light fixtures in-place to confirm UEC's findings and identify possible PCB-containing ballasts in the building. The inspection involved visually inspecting labels on representative light ballasts to identify manufacture dates and labels indicating "No PCBs". Ballasts manufactured after 1991 were not listed as PCB- or DEHP-containing ballasts and were not quantified for disposal. An in-place inventory of the fluorescent lamps/tubes and other mercury-containing equipment was completed concurrently. During this inspection, DEHP-containing fluorescent light ballasts and mercury-containing light tubes were identified in the building.

## 4.4 Conclusions and Recommendations

DEHP-containing fluorescent light ballasts and mercury-containing equipment were identified in the building during this inspection.

Fluorescent light ballasts marked as "No PCBs" with date labels indicating manufacture prior to 1991 are presumed to contain DEHP. DEHP-containing ballasts must be segregated for proper packaging, transporting, and disposal as non-PCB hazardous waste. Note that disposal requirements for DEHP-containing ballasts are slightly varied, and disposal costs are slightly less than PCB-containing light ballasts.

According to the EPA, mercury-containing equipment is characterized as a hazardous waste and mercury lamps/tubes are characterized as a Universal Waste. The mercury-containing equipment and fluorescent lamps/tubes identified in the proposed renovation areas must be recycled, reclaimed, or disposed as hazardous waste prior to disturbance.

Report prepared by Environmental Analyst, Jonathan Hand.

Reviewed by:

Dustin A. Diedricksen
Project Manager

FUSS & O'NEILL
EnviroScience, LLC

# Tables

FUSS & O'NEILL
EnviroScience, LLC

**Table 1**
**Suspect Asbestos-Containing Materials Laboratory Analytical Data Summary**

**Gibbs School**
**Arlington, Massachusetts**

Finegold Alexander Architects
November 2016
Fuss & O'Neill EnviroScience, LLC No. 20160627.A1E

| Sample Number | Material Type | NESHAP Category | Sample Location | Result | Comments |
|---|---|---|---|---|---|
| 01-JH-1010 | Gray Mudded Fitting Insulation | Non-ACM | Hall Outside Theater | ND | Supplemental Sample to UEC 32 - 34 |
| 02-JH-1010 | 12" x 12" Red Floor Tile | Non-ACM | Theater | ND | Supplemental Sample to UEC 65 |
| 03-JH-1010 | Yellow Mastic Associated with 12" x 12" Red Floor Tile | Non-ACM | Theater | ND | Supplemental Sample to UEC 67 |
| 04A-JH-1010 | 4" Brown Vinyl Baseboard | Non-ACM | Hall Outside Theater | ND | |
| 04B-JH-1010 | 4" Brown Vinyl Baseboard | Non-ACM | 1928 Building - 2nd Floor Hall | ND | |
| 05A-JH-1010 | Brown Adhesive Associated with 4" Brown Vinyl Baseboard | Non-ACM | Hall Outside Theater | ND | |
| 05B-JH-1010 | Brown Adhesive Associated with 4" Brown Vinyl Baseboard | Non-ACM | 1928 Building - 2nd Floor Hall | ND | |
| 06A-JH-1010 | Black Stair Tread | Non-ACM | Theater | ND | |
| 06B-JH-1010 | Black Stair Tread | Non-ACM | Theater | ND | |
| 07A-JH-1010 | White Adhesive Associated with Black Stair Tread | Non-ACM | Theater | ND | |
| 07B-JH-1010 | White Adhesive Associated with Black Stair Tread | Non-ACM | Theater | ND | |
| 08A-JH-1010 | Tan Atrium Window Foot-Joint Caulking | Non-ACM | Atrium | ND | |
| **09A-JH-1010** | **Brown Stair Tread Adhesive** | **Cat 1 NF** | **Atrium** | **2% Chrysotile** | |
| **09B-JH-1010** | **Brown Stair Tread Adhesive** | **Cat 1 NF** | **Gym/Library Entrance** | **Pos Stop** | |
| 10A-JH-1010 | White Plaster Skim Coat | Non-ACM | Atrium Custodian Closet | ND | Supplemental Sample to UEC 1 - 7 |
| 11A-JH-1010 | Gray Mudded Fitting Insulation | Non-ACM | 1st Floor - Dark Room | ND | Supplemental Sample to UEC 32 - 34 |
| 12A-JH-1010 | 4" Green Vinyl Baseboard | Non-ACM | 1st Floor - Hallway | ND | |
| 12B-JH-1010 | 4" Green Vinyl Baseboard | Non-ACM | 1st Floor - Southwest Room | ND | |
| 13A-JH-1010 | Tan Adhesive Associated with 4" Green Vinyl Baseboard | Non-ACM | 1st Floor - Hallway | ND | |
| 13B-JH-1010 | Tan Adhesive Associated with 4" Green Vinyl Baseboard | Non-ACM | 1st Floor - Southwest Room | ND | |
| **14A-JH-1010** | **White Generator Exhaust Insulation** | **Friable** | **1st Floor - Generator Room** | **10% Chrysotile** | |
| **14B-JH-1010** | **White Generator Exhaust Insulation** | **Friable** | **1st Floor - Generator Room** | **Pos Stop** | |
| **14C-JH-1010** | **White Generator Exhaust Insulation** | **Friable** | **1st Floor - Generator Room** | **Pos Stop** | |
| **15A-JH-1010** | **Gray Sidlight Glazing Compound** | **Cat 2 NF** | **1st Floor - Entry** | **2% Chrysotile** | |
| 16-JH-1010 | White Joint Compound | Non-ACM | 2nd Floor - Tech Lab | ND | Supplemental Sample to UEC 23 & 24 |
| 17-JH-1010 | Gray Drywall | Non-ACM | 2nd Floor - Tech Lab | ND | |
| 18A-JH-1010 | Brown Laboratory Counter Top | Non-ACM | 2nd Floor - Science Classroom | ND | |
| 18B-JH-1010 | Brown Laboratory Counter Top | Non-ACM | 2nd Floor - Science Classroom | ND | |
| 19A-JH-1010 | Black Laboratory Counter Top Adhesive | Non-ACM | 2nd Floor - Science Classroom | ND | |

FUSS & O'NEILL
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**Table 1**
**Suspect Asbestos-Containing Materials Laboratory Analytical Data Summary**

| Sample Number | Material Type | NESHAP Category | Sample Location | Result | Comments |
|---|---|---|---|---|---|
| 19B-JH-1010 | Black Laboratory Counter Top Adhesive | Non-ACM | 2nd Floor - Science Classroom | ND | |
| 20A-JH-1010 | Tan Vented Baseboard Adhesive | Non-ACM | Gym | ND | TEM |
| 20B-JH-1010 | Tan Vented Baseboard Adhesive | Non-ACM | Gym | ND | |
| 21A-JH-1010 | White Transom Window Glazing Compound | Non-ACM | Old Gym Entrance | ND | |
| 21B-JH-1010 | White Transom Window Glazing Compound | Non-ACM | Old Gym Entrance | ND | |
| 22A-JH-1010 | White Door Caulking | Non-ACM | Old Gym Entrance | ND | |
| 22B-JH-1010 | White Door Caulking | Non-ACM | Old Gym Entrance | ND | |
| 23A-JH-1010 | Brown Window Caulking | Non-ACM | 1973 Addition Exterior | ND | TEM |
| 23B-JH-1010 | Brown Window Caulking | Non-ACM | 1973 Addition Exterior | ND | |
| 24A-JH-1010 | Brown Window Caulking | Non-ACM | 1928 Building | ND | TEM |
| 24B-JH-1010 | Brown Window Caulking | Non-ACM | 1928 Building | ND | |
| **25A-JH-1010** | **Gray Original Window Caulking** | **Cat 2 NF** | **Gym Exterior** | **3% Chrysotile** | |
| **25B-JH-1010** | **Gray Original Window Caulking** | **Cat 2 NF** | **Gym Exterior** | **Pos Stop** | |

Cat 1 NF = Category I Non-Friable Material
Cat 2 NF = Category II Non-Friable Material
Pos Stop = Positive Stop
ND = None Detected
ACM = Asbestos-Containing Material
ACWM = Asbestos-Containing Waste Material
TEM = Transmission Electron Microscopy

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**Table 2**
**Asbestos-Containing Materials Summary**

**Gibbs School**
**Arlington, Massachusetts**

Finegold Alexander Architects
November 2016
Fuss & O'Neill EnviroScience, LLC No. 20160627.A1E

| Material Type | Locations(s) | Asbestos Content | Estimated Total Quantity | Comments |
|---|---|---|---|---|
| Brown Stair Tread Adhesive | Atrium & 1928 Building Stairwells | 2% Chrysotile | 1,500 SF | |
| White Generator Exhaust Insulation | Generator Room | 10% Chrysotile | 200 LF | |
| Gray Sidlight Glazing Compound | Tuft Street Main Entry | 2% Chrysotile | 1 EA @ 12' x 12' | |
| Gray Original Window Caulking | Gym/Library Entrance | 3% Chrysotile | 100 LF | |
| Fire Door Core Insulation | Throughout Interior | 12% - 27% Asbestos | 110 EA | |
| Debris | 2nd Floor Ceiling Plenum | 50% Asbestos | 10,000 SF | |
| Pipe Insulation | Boiler Room, Stairwells, 2nd Floor Ceiling Plenum, and Concealed Above Fixed Ceilings & Within Chases | 50% Asbestos | 2,500 LF | |
| Boiler Insulation | Boiler Room | 40% Asbestos | 225 SF | |
| Breeching Insulation | Boiler Room | Assumed ACM | 160 SF | |
| Heat Exchanger Insulation | Boiler Room | Assumed ACM | 225 SF | |
| Interior Boiler Components | Boiler Room | Assumed ACM | 1 EA | |
| Incinerator | Boiler Room | Assumed ACM | 1 EA | |
| Brown Sink Undercoating | 1928 Building Classrooms | >1% Asbestos | 20 EA | |
| 12" x 12" Brown Mottled Floor Tile & Associated Mastic | Throughout Buildings | 2% - 10% Asbestos | 48,000 SF | |
| 9" x 9" Floor Tile & Associated Mastic | Generator Room | Assumed ACM | 75 SF | |
| Gray Exterior Sill Caulking | 1928 Building Exterior | 5% Asbestos | 300 LF | |
| Black Veneer Dampproofing | 1973 Building Exterior | 5% Asbestos | 7,000 SF | |
| Partition Window Glazing Compound | Room Between the Science Classrooms & 1973 Building - 2nd Floor | 2% Asbestos | 40 EA | |
| Ceramic Floor/Wall Tile Adhesives, Grout, & Mud-Set Mortar | Bathrooms | Assumed ACM | 4,250 SF | |
| Black Board Adhesive | Classrooms | Assumed ACM | 1,350 SF | |
| Roofing Materials | Roofs | Assumed ACM | 30,000 SF | |

EA = Each, LF = Linear Feet, SF = Square Feet

ACM = Asbestos-Containing Material

ACWM = Asbestos-Containing Waste Material

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EnviroScience, LLC

# Appendix A

## Limitations

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EnviroScience, LLC

**APPENDIX A**

**Gibbs School**
**Arlington, Massachusetts**

1. This environmental report has been prepared for the exclusive use of the Client, and is subject to, and is issued in connection with, the general terms and conditions of the revised Agreement (September 7, 2016) and all of its provisions. Any use or reliance upon information provided in this report, without the specific written authorization of the Client and EnviroScience, shall be at the User's individual risk. This report should not be used as an abatement specification. All quantities of materials identified during this inspection are approximate.
2. EnviroScience has obtained and relied upon laboratory analytical results in conducting the inspection. This information was used to form conclusions regarding the types and quantities of ACM that must be managed prior to renovation or demolition activities that may disturb these materials at the subject property(ies). EnviroScience has not performed an independent review of the reliability of this laboratory data.
3. Unless otherwise noted, only suspect hazardous materials associated within or located on the building (aboveground) were included in this inspection. Suspect hazardous materials may exist below the ground surfaces that were not included in the scope of work of this inspection. EnviroScience cannot guarantee all asbestos or suspect hazardous materials were identified within the areas included in the scope of work. Only visible and accessible areas were included in the scope of work for this inspection.
4. The findings, observations, and conclusions presented in this report are limited by the scope of services outlined in our original Agreement, which reflects schedule and budgetary constraints imposed by the Client. Furthermore, the assessment has been conducted in accordance with generally accepted environmental practices. No other warranty, expressed or implied, is made.
5. The conclusions presented in this report are based solely upon information gathered by EnviroScience to date. Should further environmental or other relevant information be discovered at a later date, the Client should immediately bring the information to EnviroScience's attention. Based upon an evaluation and assessment of relevant information, EnviroScience may modify the report and its conclusions.
6. EnviroScience has obtained and relied upon information from multiple sources to form certain conclusions regarding likely environmental issues at and in the vicinity of the subject property in conducting this inspection. Except as otherwise noted, no attempt has been made to verify the accuracy or completeness of such information or verify compliance by any party with federal, state or local laws or regulations.

FUSS & O'NEILL
EnviroScience, LLC

# Appendix B

## EnviroScience Asbestos Inspector State Certifications and EPA Accreditations

**Commonwealth of Massachusetts**

***Department of Labor Standards***

*William D. McKinney, Director*

**Asbestos Inspector**

**JONATHAN L. HAND**

Eff. Date 02/29/16

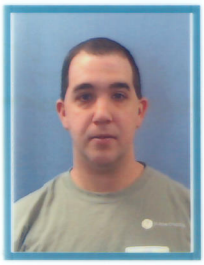
Exp. Date 02/28/17

**17**

AI041945

Member of C.O.N.E.S.

BOSR BOS-RENEW



# Certificate of Training

This program was presented at
Fuss & O'Neill Enviro Science in.
Manchester, CT with the prior
approval of the CTDPH.

*Awarded to*

**JONATHAN HAND**

***For successful completion of a 4 Hour, 1/2 Day***

***Asbestos Building Inspector***

***Annual Refresher Training***

***January 12, 2016***

**This training was approved and given in accordance with the Regulations for Connecticut State Agencies RCSA 20 - 440 - 1-9 and RCSA 20 - 441 and meets the requirements of the EPA Revised MAP under TSCA Title II of 4/4/94.**

*Presented by*

**Mystic Air Quality Consultants, Inc.**

**1204 North Road, Groton, CT 06340 (800) 247-7746**

**Certificate Number:** ABIRF24672 **Exam Grade: 100** **Exam Date: 01/12/2016** **Expiration Date: 01/12/2017**

*Christopher J. Eident, CIH, CSP, RS*

*George Williamson, Training Director*

Richard Haffey, Training Director

**Commonwealth of Massachusetts**
**Department of Labor Standards**
*William D. McKinney, Director*

**Asbestos Inspector**

**CHRISTOPHER MCINTYRE**

Eff. Date 07/20/16
Exp. Date 07/27/17
AI900564
Member of C.O.N.E.S.
BOSR BOS-RENEW

**17**

*This is to certify that*

# Christopher McIntyre

*has completed the requisite training, and has passed an examination for reaccreditation as:*

## Asbestos Inspector Refresher

pursuant to Title II of the Toxic Substance Control Act, 15 U.S.C. 2646

**Course Location**

**Institute for Environmental Education, Inc.**
**16 Upton Drive Wilmington, MA 01887**

**April 14, 2016**
Course Dates

**16-0249-106-260155**
Certificate Number

**April 14, 2016**
Examination Date

**April 14, 2017**
Expiration Date

Training Director

16 Upton Drive, Wilmington, MA 01887 Telephone 978.658.5272 www.ieetrains.com

**INSTITUTE FOR ENVIRONMENTAL EDUCATION**

FUSS & O'NEILL
EnviroScience, LLC

# Appendix C

## Asbestos Laboratory Analytical Reports and Chain-of-Custody Forms

# EMSL Analytical, Inc.

**7 Constitution Way, Suite 107 Woburn, MA 01801**

Tel/Fax: (781) 933-8411 / (781) 933-8412

http://www.EMSL.com / bostonlab@emsl.com


| | |
|---|---|
| **EMSL Order:** | 131604929 |
| **Customer ID:** | ENVI54 |
| **Customer PO:** | 20160627.A1E |
| **Project ID:** | |

| | | | |
|---|---|---|---|
| **Attention:** | Jon Hand | **Phone:** | (401) 595-8270 |
| | Fuss & O'Neill EnviroScience, LLC | **Fax:** | (888) 838-1160 |
| | 146 Hartford Road | **Received Date:** | 10/12/2016 9:20 AM |
| | Manchester, CT 06040 | **Analysis Date:** | 10/17/2016 |
| | | **Collected Date:** | 10/10/2016 |

**Project:** 20160627.A1E / Gibbs School Renovation / 41 Foster Street, Arlington, MA

## *Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy*

| | | | Non-Asbestos | | Asbestos |
|---|---|---|---|---|---|
| **Sample** | **Description** | **Appearance** | **% Fibrous** | **% Non-Fibrous** | **% Type** |
| 01-JH-1010<br>*131604929-0001* | Hall o/s Theater - Gray Mudded Fitting Insulation | Gray<br>Non-Fibrous<br>Homogeneous | 2% Cellulose<br>8% Min. Wool | 90% Non-fibrous (Other) | None Detected |
| 02-JH-1010<br>*131604929-0002* | Theater - 12"x12" Red Floor Tile | Red<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 03-JH-1010<br>*131604929-0003* | Theater - Yellow Mastic a/w 02 | Yellow<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 04A-JH-1010<br>*131604929-0004* | Hall o/s Theater - 4" Brown Vinyl Baseboard | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 04B-JH-1010<br>*131604929-0005* | 1928 Building - 2nd Floor Hall - 4" Brown Vinyl Baseboard | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 05A-JH-1010<br>*131604929-0006* | Hall o/s Theater - Brown Adhesive a/w 04 | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 05B-JH-1010<br>*131604929-0007* | 1928 Building - 2nd Floor Hall - Brown Adhesive a/w 04 | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 06A-JH-1010<br>*131604929-0008* | Theater - Black Stair Tread | Black<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 06B-JH-1010<br>*131604929-0009* | Theater - Black Stair Tread | Black<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 07A-JH-1010<br>*131604929-0010* | Theater - White Adhesive a/w 06 | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 07B-JH-1010<br>*131604929-0011* | Theater - White Adhesive a/w 06 | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 08A-JH-1010<br>*131604929-0012* | Atrium - Tan Atrium Window Foot-Joint Caulking | Tan<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 08B-JH-1010<br>*131604929-0013* | Atrium - Tan Atrium Window Foot-Joint Caulking | | | | Not Submitted |
| 09A-JH-1010<br>*131604929-0014* | Atrium - Brown Stair Tread Adhesive | Brown<br>Non-Fibrous<br>Homogeneous | | 98% Non-fibrous (Other) | 2% Chrysotile |
| 09B-JH-1010<br>*131604929-0015* | Gym/Auditorium Entrance - Brown Stair Tread Adhesive | | | | Positive Stop (Not Analyzed) |
| 10A-JH-1010<br>*131604929-0016* | Atrium Custodian Closet - White Plaster Skim Coat | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |

Initial report from: 10/17/2016 09:41:22

**EMSL Analytical, Inc.**
**7 Constitution Way, Suite 107 Woburn, MA 01801**
Tel/Fax: (781) 933-8411 / (781) 933-8412
http://www.EMSL.com / bostonlab@emsl.com

**EMSL Order:** 131604929
**Customer ID:** ENVI54
**Customer PO:** 20160627.A1E
**Project ID:**

## *Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy*

| | | | Non-Asbestos | | Asbestos |
|---|---|---|---|---|---|
| **Sample** | **Description** | **Appearance** | **% Fibrous** | **% Non-Fibrous** | **% Type** |
| 11A-JH-1010<br>*131604929-0017* | 1st Floor - Dark Room - Gray Mudded Fitting Insulation | Gray<br>Fibrous<br>Homogeneous | 20% Min. Wool | 80% Non-fibrous (Other) | None Detected |
| 12A-JH-1010<br>*131604929-0018* | 1st Floor - Hallway - 4" Green Vinyl Baseboard | Green<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 12B-JH-1010<br>*131604929-0019* | 1st Floor - Southwest Room - 4" Green Vinyl Baseboard | Green<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 13A-JH-1010<br>*131604929-0020* | 1st Floor - Hallway - Tan Adhesive a/w 12 | Yellow<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 13B-JH-1010<br>*131604929-0021* | 1st Floor - Southwest Room - Tan Adhesive a/w 12 | Yellow<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 14A-JH-1010<br>*131604929-0022* | 1st Floor - Generator Room - White Generator Exhaust Insulation | White<br>Fibrous<br>Homogeneous | 20% Glass | 70% Non-fibrous (Other) | 10% Chrysotile |
| 14B-JH-1010<br>*131604929-0023* | 1st Floor - Generator Room - White Generator Exhaust Insulation | | | | Positive Stop (Not Analyzed) |
| 14C-JH-1010<br>*131604929-0024* | 1st Floor - Generator Room - White Generator Exhaust Insulation | | | | Positive Stop (Not Analyzed) |
| 15A-JH-1010<br>*131604929-0025* | 1st Floor - Entry - Gray Sidlight Glazing Compound | Gray<br>Non-Fibrous<br>Homogeneous | | 98% Non-fibrous (Other) | 2% Chrysotile |
| 16-JH-1010<br>*131604929-0026* | 2nd Floor - Tech Lab - White Joint Compound | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 17-JH-1010<br>*131604929-0027*<br>*Sample appears to be joint compound.* | 2nd Floor - Tech Lab - Gray Drywall | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 18A-JH-1010<br>*131604929-0028* | 2nd Floor - Science Classroom - Brown Laboratory Counter Top | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 18B-JH-1010<br>*131604929-0029* | 2nd Floor - Science Classroom - Brown Laboratory Counter Top | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 19A-JH-1010<br>*131604929-0030* | 2nd Floor - Science Classroom - Black Laboratory Counter Top Adhesive | Black<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 19B-JH-1010<br>*131604929-0031* | 2nd Floor - Science Classroom - Black Laboratory Counter Top Adhesive | Black<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 20A-JH-1010<br>*131604929-0032* | Gym - Tan Vented Baseboard Adhesive | Tan<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |

Initial report from: 10/17/2016 09:41:22

**EMSL Analytical, Inc.**
**7 Constitution Way, Suite 107 Woburn, MA 01801**
Tel/Fax: (781) 933-8411 / (781) 933-8412
http://www.EMSL.com / bostonlab@emsl.com

**EMSL Order:** 131604929
**Customer ID:** ENVI54
**Customer PO:** 20160627.A1E
**Project ID:**

## *Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy*

| | | | Non-Asbestos | | Asbestos |
|---|---|---|---|---|---|
| **Sample** | **Description** | **Appearance** | **% Fibrous** | **% Non-Fibrous** | **% Type** |
| 20B-JH-1010<br>*131604929-0033* | Gym - Tan Vented Baseboard Adhesive | Tan<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 21A-JH-1010<br>*131604929-0034* | Old Gym Entrance - White Transom Window Glazing Compound | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 21B-JH-1010<br>*131604929-0035* | Old Gym Entrance - White Transom Window Glazing Compound | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 22A-JH-1010<br>*131604929-0036* | Old Gym Entrance - White Door Caulking | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 22B-JH-1010<br>*131604929-0037* | Old Gym Entrance - White Door Caulking | White<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 23A-JH-1010<br>*131604929-0038* | 1973 Addition Exterior - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 23B-JH-1010<br>*131604929-0039* | 1973 Addition Exterior - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 24A-JH-1010<br>*131604929-0040* | 1928 Building - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 24B-JH-1010<br>*131604929-0041* | 1928 Building - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | | 100% Non-fibrous (Other) | None Detected |
| 25A-JH-1010<br>*131604929-0042* | Gym Exterior - Gray Original Window Caulking | Gray<br>Non-Fibrous<br>Homogeneous | | 97% Non-fibrous (Other) | 3% Chrysotile |
| 25B-JH-1010<br>*131604929-0043* | Gym Exterior - Gray Original Window Caulking | | | | Positive Stop (Not Analyzed) |

Analyst(s)
*Michael Mink (38)*

Steve Grise, Laboratory Manager
or Other Approved Signatory



Initial report from: 10/17/2016 09:41:22

OrderID: 131604929

131604929

FUSS & O'NEILL
EnviroScience, LLC

EMSL Customer No. ENVI54

www.fando.com

50 Redfield Street, Suite 100, Boston, MA 02122

Phone (617) 282-4675 Fax (617) 282-8253

# Asbestos Bulk Sample Chain-of-Custody Form

Sheet 1 of 3

**Project Name:** Gibbs School Renovation **Project No.:** 20160627.A1E **Task:** 15

**Building Name/Number:** Gibbs Elementary School **Project Manager:** Dustin Diedricksen

**Site Address:** 41 Foster Street, Arlington, MA **Total # of Samples:** 43

| Sample ID (#-Initials-Date) | Material Type (Size, Color, Description, Material) | Sample Location | Comments/ Quantities |
|---|---|---|---|
| 01 -JH-1010 | Gray Mudded Fitting Insulation | Hall o/s Theater | |
| 02 | 12"x12" Red Floor Tile | Theater | |
| 03 | Yellow Mastic Adv 02 | ↓ | |
| 04A | 4" Brown vinyl Baseboard | Hall o/s Theater | |
| 04B | ↓ | 1928 Building - 2nd Floor Hall | |
| 05A | Brown Adhesive Adv 04 | Hall o/s Theater | |
| 05B | ↓ | 1928 Building - 2nd Floor Hall | |
| 06A | Black stair Tread | Theater | |
| 06B | ↓ | ↓ | |
| 07A | White Adhesive Adv 06 | ↓ | |
| 07B | ↓ | ↓ | |
| 08A | Tan Atrium window Fast-Joint Caulking | Atrium | |
| 08B | ↓ | ↓ | |
| 09A | Brown Stair tread Adhesive | ↓ | |
| 09B | ↓ | Gym/Auditorium Entrance | |

**Analysis Method:** ☒ PLM ☒ TEM ☐ Other _____ Turnaround Time: 72-hour

Please call EnviroScience at (617) 282-4675 if analyses will not be completed for requested turnaround time listed above.

**Email Results to:** jhand & ddiedricksen @fando.com **Do Not Mail Hard Copy Report** **FAX Results to: 888-838-1160.**

**Special Instructions:** Stop analysis on first positive sample in each homogeneous set of samples unless otherwise noted. Do not layer samples unless indicated. Do not point count. If NOB group samples are **ALL** negative by PLM, analyze the sample denoted with a star (★) by **TEM NOB** on a [72-hour] turnaround time. Analyze a **MAXIMUM** of [3] samples by **TEM in noted order.**

**Samples Collected by:** Jonathan Hand **Date:** 10/10/16

**Samples Sent by:** Jon Hand **Date:** 10/11/16 **Time:**

**Shipped To:** ☒ EMSL ☐ Other EMSL FedEx

**Method of Shipment:** ☒ Fed Ex ☐ Lab Drop Off ☐ Other 7951 4772 9053

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OCT 12 2016
By MM 920

OrderID: 131604929

131604929

FUSS & O'NEILL
EnviroScience, LLC

EMSL Customer No. ENVI54

www.fando.com

50 Redfield Street, Suite 100, Boston, MA 02122 Phone (617) 282-4675 Fax (617) 282-8253

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**Building Name/Number:** Gibbs Elementary School **Project Manager:** Dustin Diedricksen

**Site Address:** 41 Foster Street, Arlington, MA **Total # of Samples:**

| Sample ID (#-Initials-Date) | Material Type (Size, Color, Description, Material) | Sample Location | Comments/ Quantities |
|---|---|---|---|
| 10A -JH-1010 | White Plaster Skim Coat | Atrium Custodian Closet | |
| 11A | Gray Molded Fitting Insulation | 1st Floor - Dark Room | |
| 12A | 4" Green Vinyl Baseboard | ↓ - Hallway | |
| 12B | ↓ | ↓ - Southwest Room | |
| 13A | Tan Adhesive A/W 12 | ↓ - Hallway | |
| 13B | ↓ | ↓ - South west Room | |
| 14A | White Generator Exhaust Insulation | ↓ - Generator Room | |
| 14B | ↓ | ↓ - ↓ | |
| 14C | ↓ | ↓ - ↓ | |
| 15A | Gray Sidelight Glazing Compound | ↓ - Entry | |
| 16 | White Joint Compound | 2nd Floor - Tech Lab | |
| 17 | Gray Drywall | ↓ - ↓ | |
| 18A | Brown Laboratory Counter Top | ↓ - Science Classroom | |
| 18B | ↓ | ↓ - ↓ | |
| 19A | Black Laboratory Counter Top Adhesive | ↓ - ↓ | |

**Analysis Method:** ☒ PLM ☒ TEM ☐ Other Turnaround Time: 72-hour

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**Shipped To:** ☒ EMSL ☐ Other

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|---|---|---|---|
| 19B -JH-1010 | ↓ | ↓ | |
| 20A | Tan Vented Baseboard Adhesive | Gym | |
| 20B | ↓ | ↓ | |
| 21A | white Transom Window Glazing Compound | old Gym Entrance | 2 @ 3'x4' |
| 21B | ↓ | ↓ | |
| 22A | white Door Caulking | | 30 lf |
| 22B | ↓ | ↓ | |
| 23A | Brown Window Caulking | 1973 Addition Exterior | |
| 23B | ↓ | ↓ | |
| 24A | ↓ | 1928 Building | Replaced in 80's |
| 24B | ↓ | ↓ | |
| 25A | Gray Original Window Caulking | Gym Exterior | |
| 25B | ↓ | ↓ | |
| | | | |
| | | | |

**Analysis Method:** ☒ PLM ☒ TEM ☐ Other Turnaround Time: 72-hour

Please call EnviroScience at (617) 282-4675 if analyses will not be completed for requested turnaround time listed above.

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**Samples Collected by:** Jon Hand **Date:** 10/10/16

**Samples Sent by:** Jon Hand **Date:** 10/11/16 **Time:** PM

**Shipped To:** ☒ EMSL ☐ Other

**Method of Shipment:** ☒ Fed Ex ☐ Lab Drop Off ☐ Other

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OCT 12 2016
By MM 920

EMSL Analytical, Inc.
7 Constitution Way, Suite 107 Woburn, MA 01801
Tel/Fax: (781) 933-8411 / (781) 933-8412
http://www.EMSL.com / bostonlab@emsl.com

**EMSL Order:** 131604929
**Customer ID:** ENVI54
**Customer PO:** 20160627.A1E
**Project ID:**

**Attention:** Jon Hand
Fuss & O'Neill EnviroScience, LLC
146 Hartford Road
Manchester, CT 06040

**Phone:** (401) 595-8270
**Fax:** (888) 838-1160
**Received Date:** 10/12/2016 9:20 AM
**Analysis Date:** 10/20/2016
**Collected Date:** 10/10/2016

**Project:** 20160627.A1E / Gibbs School Renovation / 41 Foster Street, Arlington, MA

## Test Report: Asbestos Analysis of Non-Friable Organically Bound Materials by TEM via EPA/600/R-93/116 Section 2.5.5.1

| Sample ID | Description | Appearance | % Matrix Material | % Non-Asbestos Fibers | Asbestos Types |
|---|---|---|---|---|---|
| 20A-JH-1010<br>*131604929-0032* | Gym - Tan Vented Baseboard Adhesive | Tan<br>Non-Fibrous<br>Homogeneous | 100 | None | No Asbestos Detected |
| 23A-JH-1010<br>*131604929-0038* | 1973 Addition Exterior - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | 100 | None | No Asbestos Detected |
| 24A-JH-1010<br>*131604929-0040* | 1928 Building - Brown Window Caulking | Brown<br>Non-Fibrous<br>Homogeneous | 100 | None | No Asbestos Detected |

Analyst(s)

*Steve Grise (3)*

Steve Grise, Laboratory Manager
or other approved signatory



Samples analyzed by EMSL Analytical, Inc. Woburn, MA

Initial report from: 10/20/2016 17:21:13

OrderID: 131604929

131604929

FUSS & O'NEILL
EnviroScience, LLC

EMSL Customer No. ENVI54

www.fando.com

50 Redfield Street, Suite 100, Boston, MA 02122

Phone (617) 282-4675 Fax (617) 282-8253

# Asbestos Bulk Sample Chain-of-Custody Form

Sheet 1 of 3

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| 01 -JH-1010 | Gray Mudded Fitting Insulation | Hall o/s Theater | |
| 02 | 12"x12" Red Floor Tile | Theater | |
| 03 | Yellow Mastic Adv 02 | ↓ | |
| 04A | 4" Brown vinyl Baseboard | Hall o/s Theater | |
| 04B | ↓ | 1928 Building - 2nd Floor Hall | |
| 05A | Brown Adhesive Adv 04 | Hall o/s Theater | |
| 05B | ↓ | 1928 Building - 2nd Floor Hall | |
| 06A | Black stair Tread | Theater | |
| 06B | ↓ | ↓ | |
| 07A | White Adhesive Adv 06 | ↓ | |
| 07B | ↓ | ↓ | |
| 08A | Tan Atrium window Fast-Joint Caulking | Atrium | |
| 08B | ↓ | ↓ | |
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| 09B | ↓ | Gym/Auditorium Entrance | |

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|---|---|---|---|
| 10A -JH-1010 | White Plaster Skim Coat | Atrium Custodian Closet | |
| 11A | Gray Molded Fitting Insulation | 1st Floor - Dark Room | |
| 12A | 4" Green Vinyl Baseboard | ↓ - Hallway | |
| 12B | ↓ | ↓ - Southwest Room | |
| 13A | Tan Adhesive A/W 12 | ↓ - Hallway | |
| 13B | ↓ | ↓ - South west Room | |
| 14A | White Generator Exhaust Insulation | ↓ - Generator Room | |
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| 19B -JH-1010 | ↓ | ↓ | |
| 20A | Tan Vented Baseboard Adhesive | Gym | |
| 20B | ↓ | ↓ | |
| 21A | white Transom Window Glazing Compound | old Gym Entrance | 2 @ 3'x4' |
| 21B | ↓ | ↓ | |
| 22A | white Door Caulking | | 30 lf |
| 22B | ↓ | ↓ | |
| 23A | Brown Window Caulking | 1973 Addition Exterior | |
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| 24A | ↓ | 1928 Building | Replaced in 80's |
| 24B | ↓ | ↓ | |
| 25A | Gray Original Window Caulking | Gym Exterior | |
| 25B | ↓ | ↓ | |
| | | | |
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**Method of Shipment:** ☒ Fed Ex ☐ Lab Drop Off ☐ Other

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By MM 920

FUSS & O'NEILL
EnviroScience, LLC

November 11, 2016

Ms. Regan Shields Ives, AIA, LEED AP
Senior Associate
Finegold Alexander Architects
77 North Washington Street, 7th Floor
Boston, MA 02144

**RE: Hazardous Building Materials Opinion of Abatement Costs**
**Gibbs School**
**Arlington, Massachusetts**
Fuss & O'Neill EnviroScience, LLC No. 20160627.A1E

Dear Ms. Shields Ives:

Fuss & O'Neill EnviroScience, LLC has prepared the hazardous building materials opinion of abatement cost provided below (for the abovementioned site). These cost opinions are based on our Limited Hazardous Building Materials Inspection report prepared for the Site, dated November 2016. Unit costs are based on current industry rates and are inclusive of typical contractor costs for a normal work schedule (1 shift/day), Monday to Friday. They do not include costs for an expedited work schedule (double shifts/ weekends/ holidays), project design, construction monitoring, air sampling, and other consultant-based fees. Estimated unit costs are based on assumption that listed materials will be removed, disposed, and transported by the abatement contractor during one phase.

| Material Type | Estimated Quantity | Estimated Unit Cost | Total Estimated Cost |
|---|---|---|---|
| Brown Stair Tread Adhesive | 1,500 SF | $4/SF | $6,000.00 |
| White Generator Exhaust Insulation | 200 LF | $25/LF | $5,000.00 |
| Gray Sidlight Glazing Compound - 12' x 12' | 1 EA | $2,000/EA | $2,000.00 |
| Gray Original Window Caulking | 100 LF | $7/LF | $700.00 |
| Fire Door Core Insulation | 110 EA | $150/EA | $16,500.00 |
| Debris | 10,000 SF | $10/SF | $100,000.00 |
| Pipe Insulation | 2,500 LF | $25/LF | $62,500.00 |
| Boiler Insulation | 225 SF | $25/SF | $5,625.00 |
| Breeching Insulation (Assumed ACM) | 160 SF | $25/SF | $4,000.00 |
| Heat Exchanger Insulation (Assumed ACM) | 225 SF | $25/SF | $5,625.00 |
| Interior Boiler Components (Assumed ACM) | 1 EA | $7,500/EA | $7,500.00 |
| Incinerator (Assume ACM) | 1 EA | $6,500/EA | $6,500.00 |
| Brown Sink Undercoating | 20 EA | $75/EA | $1,500.00 |

FUSS & O'NEILL
EnviroScience, LLC

| Material Type | Estimated Quantity | Estimated Unit Cost | Total Estimated Cost |
|---|---|---|---|
| 12" x 12" Brown Mottled Floor Tile & Associated Mastic | 48,000 SF | $4/SF | $192,000.00 |
| 9" x 9" Floor Tile & Associated Mastic (Assumed ACM) | 75 SF | $4/SF | $300.00 |
| Gray Exterior Sill Caulking | 300 LF | $7/LF | $2,100.00 |
| Black Veneer Dampproofing | Allotment for New Openings | | $10,000.00 |
| Partition Window Glazing Compound | 40 EA | $125/EA | $5,000.00 |
| Ceramic Floor/Wall Tile Adhesives, Grout, & Mud-Set Mortar (Assumed ACM) | 4,250 SF | $10/SF | $42,500.00 |
| Black Board Adhesive (Assumed ACM) | 1,350 SF | $10/SF | $13,500.00 |
| Roofing Materials (Assumed ACM) | 30,000 SF | $6/SF | $180,000.00 |
| Lighting Ballast, Fluorescent Lamp, and Mercury-Containing Equipment Disposal | | Lump Sum | $2,500.00 |
| Lead-Based Paint Work Practices & Limited Disposal | | Lump Sum | $5,000.00 |
| | | **Subtotal** | $676,350.00 |
| | | **(~10%) Contingency** | $67,650.00 |
| | | **Total*** | $744,000.00 |

EA = Each, LF = Linear Feet, SF = Square Feet

ACM = Asbestos-Containing Material

*Does not include consultant fees

Sincerely,

Dustin A. Diedricksen
Project Manager

DD/ftc

## Appendix B – Major Code Considerations Narrative

JENSEN HUGHES

1661 Worcester Rd | Suite 501
Framingham, MA 01701 USA
jensenhughes.com
+1 508-620-8900
Fax: +1 508-620-0908

# GIBBS SCHOOL
# ARLINGTON, MA
# MAJOR CODE CONSIDERATIONS
# NARRATIVE – DRAFT

**Prepared For**

Finegold Alexander Architects
77 N. Washington 7th Floor
Boston, MA 02114

**November 21, 2016**

Project #: 1SXG00062

## TABLE OF CONTENTS

### Contents

## 1. INTRODUCTION

JENSEN HUGHES prepared this code narrative regarding the proposed renovations to the existing Gibbs / East Junior High School (Middle School) located at 41 Foster Street in Arlington, MA.

The renovation work is intended to address the issue that the existing Middle School is currently crowded and that the student population is projected to increase. The Town of Arlington has determined that the existing Middle School will be renovated to function as a 6th grade (only) Middle School that accommodates approximately 500 students. The proposed renovation work includes a variety of work including replacing exterior walls, doors, and interior space reconfiguration. The major interior reconfiguration includes renovation to the lower level to provide a new cafeteria and kitchen. However, other spaces throughout the building will also be reconfigured to provide classrooms and other spaces as required for the new school program. It is our understanding that the building is not currently provided with an automatic fire suppression system. Upon completion of the project, the building will be protected throughout with an automatic fire sprinkler system.

The original building was constructed in 1928. The original building underwent an addition in 1973 to provide a total building area of 69,000 square feet. The existing building has 3 levels dedicated to educational purposes. The building has a parking lot that accommodates 64 cars.

The intent of this code narrative is to outline our understanding of the existing conditions and summarize the major code considerations regarding the proposed renovations. The information contained within this narrative is based on the following:

- Existing Drawings of the building provided to JENSEN HUGHES on September 9th, 2016.
- Survey of the existing building conducted on September Functional, destructive or intrusive inspections were not conducted.
- Review of Programming Plans dated October 19th 2016.
- Review of the *Renovation Study – Structural Narrative* prepared by Foley Buhl Roberts & Associates dated April 7, 2016.
- Various project related discussions between JENSEN HUGHES and Finegold Alexander Architects.

## 2. APPLICABLE CODES

The primary codes applicable to this project include:

**Table 1 – Applicable Codes**

| Code Type | Applicable Code |
|---|---|
| Building | Massachusetts State Building Code (780 CMR), 8th Edition*, based on the 2009 International Building Code and the 2009 International Existing Building Code (780 CMR 34 or MA IEBC). |
| Fire Prevention | 527 CMR – Massachusetts Fire Prevention Regulations (based on the 2012 NFPA 1) |
| Accessibility | 521 CMR – Massachusetts Architectural Access Board Regulations<br>2010 ADA Standards for Accessible Design |
| Electrical | NFPA 70, 2014 Edition, *National Electrical Code* as amended by 527 CMR 12.00 |
| Elevators | 524 CMR – Massachusetts Elevator Regulations (based on the 2004 ANSI/ASME A17.1) |
| Mechanical | 2009 International Mechanical Code (IMC) as amended by 780 CMR 28 |
| Plumbing | 248 CMR – Massachusetts Fuel Gas and Plumbing Code |
| Energy | 2015 International Energy Conservation Code (IECC) as amended by 780 CMR Chapter 13. |
| Other | National Fire Protection Association (NFPA) Standards, as referenced by the 780 CMR and 527 CMR, including:<br>NFPA 10, 2007 Edition, *Standard for Portable Fire Extinguishers*<br>NFPA 13, 2013 Edition, *Standard for the Installation of Sprinkler Systems*<br>NFPA 72, 2010 Edition, *National Fire Alarm and Signaling Code* |

* The 9th edition of 780 CMR (which adopts and amends the 2015 International Building Code) is expected to be officially adopted sometime in 2016. The effective date of the 9th edition is unknown at this time; however, the adoption will incorporate a concurrency period of 6-months where users may file building permits in compliance with the 8th or 9th edition of 780 CMR. After the 6-month concurrency period, compliance with the 9th edition of 780 CMR will be required. Based on the current project schedule, it is expected that the project will be permitted under the 8th edition of 780 CMR. Should the permit date fall beyond July 1, 2017, compliance with the 9th edition of 780 CMR may be required. JENSEN HUGHES will continue to monitor the code adoption process throughout the project.

## 3. CODE COMPLIANCE APPROACH

The following information describes the specifics associated with the code compliance evaluation performed. The evaluation takes into account the requirements of the 780 CMR, 527 CMR, and various referenced codes and standards.

The Commonwealth of Massachusetts currently adopts the 8th edition of 780 CMR and is in the process of adopting the 9th edition. All code references contained herein are with respect to the 8th edition of 780 CMR.

The legal occupancy of any building shall be permitted to continue without change, except as is deemed necessary by the code official for the general safety and welfare of the occupants and the public.

## 4. WORK CLASSIFICATION

**Definitions**

**Repairs** – Repair is defined as the restoration to good or sound condition of any part of an existing building for the purpose of its maintenance (780 CMR 34-202). Repairs include the patching or restoration or replacement of damaged materials, elements, equipment, or fixtures for the purpose of maintaining such components in good or sound condition with respect to existing load or performance requirements. Repairs must comply with the provisions of 780 CMR 34-5.0 (780 CMR 34-402.0).

**Alterations** – Alteration is defined as any construction or renovation to an existing structure other than a repair or an addition. Alterations are classified as Level 1, Level 2 and Level 3 as follows (780 CMR 34-202):

- **Level 1** – Level 1 alterations include the removal and replacement or covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment or fixtures that serve the same purpose. Level 1 alterations must comply with the provisions of 780 CMR 34-6.0 (780 CMR 34-403.0).

- **Level 2** - Level 2 alterations include the reconfiguration of space, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment. Level 2 alterations must comply with the provisions of 780 CMR 34-6.0 for Level 1 alterations and additionally 780 CMR 34-7.0 (780 CMR 34-404.0).

- **Level 3** – Level 3 alterations apply where the work area exceeds 50% of the aggregate area of the building and/or where required by a change of occupancy classification in accordance with 780 CMR 34-912.1.1. Level 3 alterations must comply with the provisions of 780 CMR 34-6.0 and 7.0 for Levels 1 and 2 alterations and additionally 780 CMR 34-8.0 (780 CMR 34-405.0).

**Change of Occupancy** – A change of occupancy is defined as a change in the purpose or level of activity within a building that involves a change in the application of the requirements of the Code (780 CMR 34-202). A change of occupancy may involve (780 CMR 34-901.1):

- Change in occupancy with no change of occupancy classification

- Change of occupancy classification or occupancy group designation

Changes of occupancy must comply with the provisions of 780 CMR 34-9.0 (780 CMR 34-406.)

**Work Area** – That portion or portions of a building consisting of all **reconfigured spaces** as indicated on the construction documents. Work area excludes other portions of the building where incidental work entailed by the intended work must be performed and portions of the building where work not initially intended by the owner is specifically required by this code (780 CMR 34-IEBC §202).

(NOTE: *Not all work includes reconfiguration of space. For example, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment do not in and of themselves include a Work Area*.)

**The Project Work**

780 CMR 34 offers multiple compliance methods to evaluate the code triggers for the project. Based on the scope of work to the existing building, the work area method has been selected as the compliance method.

The project will consist of renovation work considered as an alteration per 780 CMR 34-202.

The proposed work is expected to create work areas in more than 50% of the aggregate area of the building. **Therefore, the work is classified as a Level 3 alteration, subject to compliance with 780 CMR 34 Chapters 6, 7, and 8. If the work area is such that it does not exceed 50% of the building area, this report must be updated to exclude Level 3 alteration code requirements.**

All new work is subject to compliance with 780 CMR for new construction.

## 5. OCCUPANCY CLASSIFICATION

The existing building has been occupied by various tenants and is owned by the Town of Arlington, Massachusetts. Primarily, the building use has been educational purposes classified as an Educational Occupancy (Group E); therefore, no change of occupancy classification is required.

780 CMR 305 classifies middle school uses as Education, Group E. Accessory and incidental uses do not affect the use classification of the building.

The primary uses in the building are classrooms. Support uses include the gymnasium, auditorium, library, administrative offices, storage and mechanical rooms.

The following summarizes the primary Use Group Classifications of each of these spaces:

- Classrooms[1] — Educational, Group E (780 CMR 305)
- Administrative Offices[2] — Business, Group B

The following summarizes the accessory Use Group classifications per 780 CMR 303.1 Exception 4 and 780 CMR 508.2:

- Cafeteria — Assembly, Group A-2
- Gymnasium/Common Rooms — Assembly, Group A-3
- Library — Assembly, Group A-3
- Storage & Mechanical Spaces[3] — Storage, Group S

[1] Assumes any hazardous materials are maintained below the exempt amounts identified in 780 CMR 414.2.2.

[2] Area of offices (Resource & Spec Rooms) exceed 10% of floor area on the Third Floor and therefore does not qualify as Accessory Use per 780 CMR 508.2.

[3] These areas are classified as accessory to the main occupancies since they are less than 10% of the Floor area in which they are located (780 CMR 508.2.1)

**Accessory Assembly to Group E**

780 CMR 303.1 Exception 4 identifies that assembly areas which are accessory to the Group E are not required to be treated as separate occupancies. Therefore, it is possible to treat the assembly spaces such as common rooms, the cafeteria, and the gymnasium as part of an E Group for construction classification. The A-2/A-3 classification is still required for application of other provisions of the code including interior finish, fire protection, egress etc. For such assembly spaces to be considered part of the primary Group E occupancy, the assembly functions must be ancillary and supportive to the educational operation of the building. **Further discussion about the assembly use is required to confirm if the assembly is considered accessory to Group E use.**

**Gymnasium**

780 CMR 508.3.1 requires that spaces which can be utilized for different uses at different times to satisfy the code for each purpose. The gymnasium is classified as Assembly A-3 because it can be a multi-function space utilized for other events. If the gymnasium is provided with spectator seating it will also be classified as Assembly A-4. This report assumes that the gymnasium is not provided with spectator seating and will only be considered for Assembly A-3 space.

**Mixed-Uses**

For buildings with multiple uses, a mixed occupancy approach must be followed per 780 CMR 508.3.1. A non-separated approach requires the construction classification and fire protection requirements to be determined based on the most restrictive use in the building. All remaining provisions of the code are applied to each portion of the building based on the use therein. A non-separated mixed-use approach will be used for the building and project.

## 6. CONSTRUCTION / FIRE RESISTANCE RATINGS

Based on review of the Renovation Study Structural Narrative and observations made during the site survey, it is our understanding that the building contains an unprotected steel frame, load bearing masonry exterior walls, and concrete floor construction. This construction type is consistent Type IIB (unprotected, noncombustible) construction. The following table summarizes the fire resistance rating requirement for Type IIB construction:

**Table 2 – Fire-Resistance Rating Requirements for Building Elements**

| Building Element | Type IIB Construction |
|---|---|
| Primary Structural Frame | 0[3] |
| Exterior Bearing Walls | 0[1,3] |
| Exterior Non-Bearing Walls and Partitions | See Exterior Wall Section |
| Interior Bearing Walls | 0[2] |
| Interior Non-Bearing Walls and Partitions | 0[2] |
| Floor Construction and Secondary Members | 0 |
| Roof Construction and Secondary Members | 0 |

[1] Not less than the fire resistance rating required based on the fire separation distance.
[2] Not less than the fire resistance rating required by other areas of the code
[3] Not less than the fire resistance rating as referenced in Section 704.10

## 7. HEIGHT AND AREA LIMITATIONS

Given that there is no change in occupancy or addition, the proposed renovations do not require compliance with height and area limitations.

## 8. VERTICAL OPENINGS

In Group E occupancies, existing vertical openings not exceeding three stories are not required to be enclosed when the building is protected throughout by an approved automatic fire sprinkler system (780 CMR 34-703.2.1, Exception 6).

In Group A occupancies, a minimum 30-minute enclosure shall be provided to protect all vertical openings not exceeding three stories unless opening is permitted to be unenclosed per new construction requirements (780 CMR 34-703.2, Exception 4).

Note that, an existing building or portion thereof shall not be altered such that the building becomes less safe than its existing condition (MA IEBC 601.2). As such, the fire resistance rating of shafts and exit enclosures in the existing building shall be maintained, unless alterations conform to new construction requirements.

New vertical openings should be enclosed by a shaft enclosure unless one of the exceptions of 780 CMR 708.2 is met. It is our understanding that there will be no new vertical openings planned in the renovation. However, if any are to be proposed, new two-story vertical openings should be separated by 1-hour rated shaft construction (780 CMR 708.4) unless an applicable Exception to 780 CMR 708.2 is utilized.

In addition to the stairs and shafts within the building, the building contains vertical openings that connect the First Floor and Second Floor (marked in green in the following figures) and vertical openings from the Second Floor to the Third Floor.

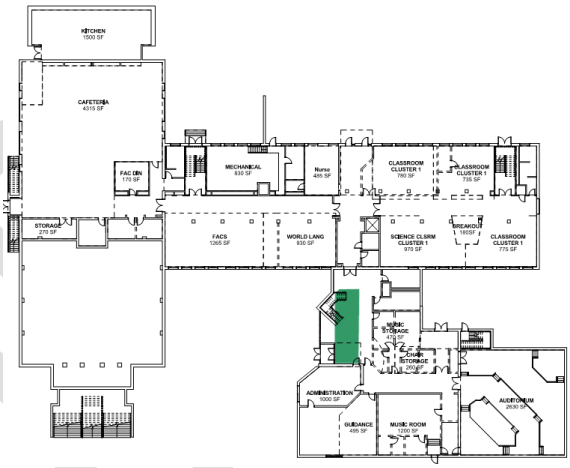


**Figure 1 - Vertical Openings (First Floor)**

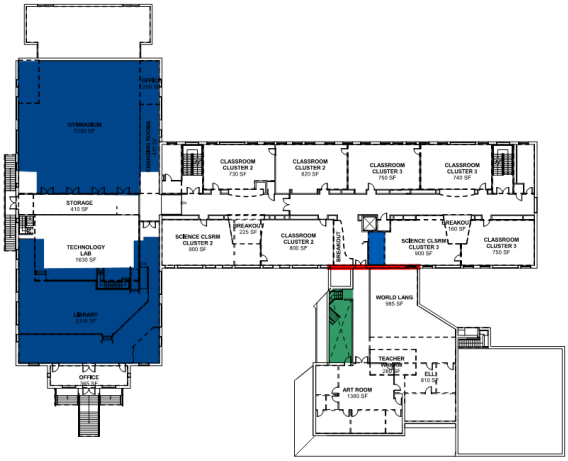

**Figure 2 - Vertical Openings (Second Floor)**

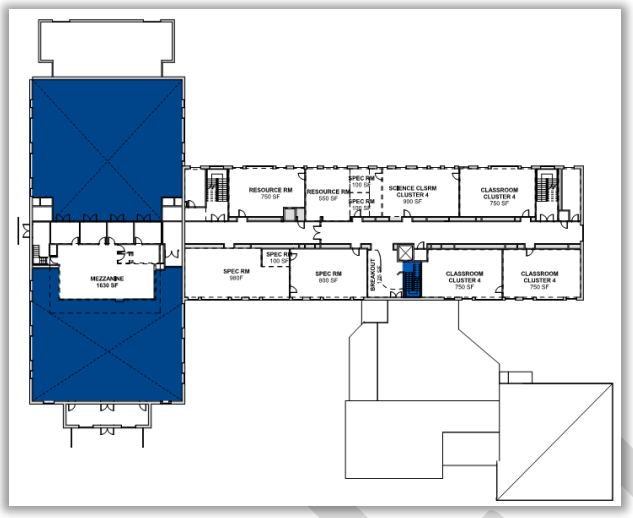


**Figure 3 - Vertical Openings (Third Floor)**

**Based on the above provisions, further discussion regarding the vertical openings in the building is recommended. If the assembly space within the building is considered ancillary and supportive to the educational operation of the building (i.e. not used for special events, etc.), the entire building can be classified as a Group E occupancy and vertical openings are not required to be enclosed. If the assembly space is not intended to be ancillary and supportive and is expected to serve assembly use other than those related to Group E Use, all vertical openings connecting two (2) or more floors are required to be protected with a minimum 30-minute enclosure. Therefore, to eliminate the requirement to protect all vertical openings, the separation between the Second Floor original building and addition should be a 1-hour rate fire barrier.**

## 9. INTERIOR FINISHES

New interior finishes and the existing interior finish of walls and ceilings in exits and corridors in any work area should comply with the code for new construction (780 CMR 34 803.3). Existing materials that do not comply with the interior finish requirements of 780 CMR are permitted to be treated with an approved fire-retardant coating in accordance with the manufacturer's instructions to achieve the required rating.

ASTM E84, *Test Methods for Surface Burning Characteristics of Building Materials* classifies the burning characteristics of building materials using flame spread and smoke development properties. Performance characteristics and classifications are developed in accordance with the following Table (780 CMR 803.1).

The following table summarizes the interior finish requirements for new construction (780 CMR 803.9).

**Table 3: Interior Finish Requirements**

| Group | Exit Enclosures and Exit Passageways | Corridors | Rooms and Enclosed Spaces |
|---|---|---|---|
| E, B | Class A or B | Class A, B, or C | Class A, B, or C |
| A-3, A-2 | Class A or B | Class A or B | Class A, B, or C |
| S | Class A, B, or C | Class A, B, or C | Class A, B, or C |

## 10. UPHOLSTERED FURNITURE

Newly upholstered furniture is required to meet one of the following (527 CMR 12.6.1.3):

- The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260, Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture, or with ASTM E 1353, Standard Test Methods for Cigarette Ignition Resistance of Components of Upholstered Furniture.

- Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1½ in. when tested in accordance with NFPA 261, Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes, or with ASTM E 1352, Standard Test Method for Cigarette Ignition Resistance of Mock-Up Upholstered Furniture Assemblies.

- The requirements of California Technical Bulletin 117-2013, Requirements, Test Procedure and Apparatus for Testing the Smolder Resistance of Materials Used in Upholstered Furniture

The manufacturer shall affix a label to each article of regulated furniture that indicates (527 CMR 12.6.3.5.1):

(1) the article of furniture is composed of materials that meet the performance test.
(2) the nationally recognized testing laboratory and standards or publications as provided in the fire code.

The label shall be stitched or adhered onto each piece of regulated furniture (527 CMR 12.6.3.5.2). The building manager shall maintain documentation of furniture within the building (527 CMR 12.6.3.6.1). The documentation shall be made available to the authority having jurisdiction upon request. The documentation shall include:

(1) The quantity and type of each article of furniture.
(2) Certification that the furniture items meet the performance requirements.
(3) The nationally recognized testing laboratory that conducted the tests.
(4) Description of the upholstery cover fabric for each type of furniture within the inventory area, if the furniture is upholstered. The description of the upholstery cover fabric shall be provided by the fabric company or the chair manufacturer, and shall include fiber content, fabric type, fabric company name, and either a photo of the fabric for identification, or an actual fabric swatch, clearly labeled, at minimum size 2 in. x 2 in.
(5) Fire retardant treatment maintenance and compliance documentation, if applicable.

## 11. FIRE PROTECTION SYSTEMS

The building is not currently provided with an automatic sprinkler system. An automatic sprinkler system shall be provided in accordance with new construction requirements. No such sprinkler system shall be required unless sufficient water supply for design of a fire sprinkler system is available without installation of a new fire pump (MA IEBC 704.1.2, 704.2.2, 780 CMR 903). The fire sprinkler system shall be supervised in accordance with Chapter 9 of 780 CMR. The building will be provided with an automatic sprinkler system as part of the proposed renovations.

An approved fire alarm system shall be provided in the building in accordance with Chapter 9 of 780 CMR. The fire alarm system should be provided with voice/emergency alarm capabilities per 780 CMR 907.2.3. In addition, devices to detect water flow in sprinkler systems and for elevator recall functions should be provided (NFPA 13, 524 CMR and 527 CMR).

Fire extinguishers are required to be provided in accordance with 527 CMR, NFPA 10, and 780 CMR Section 906.2 (780 CMR 906.1).

## 12. MEANS OF EGRESS

The First Floor of the building is provided with various exits that discharge to ground. The second floor is served by two enclosed exit stairways that discharge directly to the exterior on the First Floor and by two exits that provided access to ground through exterior exit stairways. The Third Floor is served by the same two exit stairways that serve the second floor. The building contains two open stairs that serve as convenience stairs and are not part of the means of egress. One open stair connects the First and Second Floors, and one open stairway connects the Second and Third Floors (see Vertical Openings section for more detail).

Alterations must be done in a manner that maintains the level of protection provided for the means of egress. The minimum number and capacity of exits provided must be in accordance with new construction requirements of 780 CMR Chapter 10 (780 CMR 102.5). Newly constructed means of egress are subject to compliance with the requirements in 780 CMR 10.0. The following sections outline the major requirements from this Chapter. It should be recognized that where multiple occupancies share the same portions of a means of egress system, those egress components should meet the more stringent requirements of all of the occupancies served.

### 12.1. OCCUPANT LOAD

The occupant load for each floor should be determined using the greater of the following (780 CMR 1004.1):

- Occupant load calculations using factors prescribed by 780 CMR Table 1004.1.1, summarized in the table below.
- The actual number of occupants who will use each space or floor.

**Table 4 - Occupant Load Factors**

| Function of Space | Occupant Load Factor ($ft^2$/occ.) |
|---|---|
| Assembly Concentrated (chairs only- not fixed) | 7 Net |
| Assembly without fixed seats (Tables and Chairs) | 15 Net |
| Classrooms | 20 Net |
| Exercise Rooms | 50 Gross |
| Kitchen | 200 Gross |
| Office | 100 Gross |
| Storage/MEP Rooms | 300 Gross |
| Assembly with Fixed Seating | # of Seats |

Where approved by the building official, the actual number of occupants for whom each occupied space, floor or building is designed, although less than those determined by calculation, is permitted to be used in the determination of the design occupant load (780 CMR 1004.1.1 Exception). **The anticipated building occupancy is 550 people, including 500 students and an additional 50 faculty and staff. The following table summarizes the calculated occupant load as prescribed per 780 CMR 1004.1. It should be noted that the calculated occupant load is used solely to determine the adequacy of the means of egress as it is conservative in respect to the actual occupancy of the building.**

**Table 5 – Occupant Load**

| Floor | Room | Area | Load Factor | OL |
|---|---|---|---|---|
| **Level 1** | Kitchen | 1500 | 200 | 8 |
| | Cafeteria | 4315 | 15 | 288 |
| | FACS | 1265 | 20 | 64 |
| | World Lang | 930 | 20 | 47 |
| | Classrooms | 3260 | 20 | 163 |
| | Breakout | 180 | 15 | 12 |
| | Auditorium[4] | 2630 | 7 | 376 |
| | Music Room | 1200 | 20 | 60 |
| | Business | 1980 | 100 | 20 |
| | Storage/MEP | 2000 | 300 | 7 |
| | | | **Floor Total =** | **1045** |
| **Level 2** | Gymnasium[5] | 5190 | 15 | 346 |
| | Changing Room | 410 | 50 | 9 |
| | Library Reading Area | 1655 | 50 | 34 |
| | Library Stacks | 1655 | 100 | 17 |
| | Technology Lab | 1630 | 20 | 82 |
| | Breakout | 385 | 15 | 26 |
| | Classrooms | 6390 | 20 | 320 |
| | World Lang | 985 | 20 | 50 |
| | Art Room | 1380 | 50 | 28 |
| | ELL | 810 | 20 | 41 |
| | Storage/MEP | 410 | 300 | 2 |
| | | | **Floor Total =** | **955** |
| **Level 3** | Resource Rooms | 3380 | 100 | 34 |
| | Breakout | 175 | 15 | 12 |
| | Classrooms | 3150 | 20 | 158 |
| | | | **Floor Total =** | **204** |

4 For a conservative calculation the auditorium space occupant load is calculated at the “Concentrated Assembly” occupant load factor. If provided with fixed seating, the occupant load based on the fixed number of seats may be used.

5 For a conservative calculation the Gymnasium space occupant load is calculated as Unconcentrated Assembly space, (at 15 occ/ft$^2$) rather than at the Exercise Room occupant load factor (50 occ/ft$^2$) with the assumption that the space may be used for assembly purposes for school events.

## 12.2. EGRESS CAPACITY AND NUMBER OF EXITS

Each floor of the building is required to minimally have a number of exits specified in Table 1021.1, based on the calculated occupant load of each floor (780 CMR 1021.1). The following table outlines the minimum number of exits required for every floor:

**Table 6 - Minimum Number of Exits**

| Occupant Load (persons) | Minimum Number of Exits (per story) |
|---|---|
| 1-500 | 2 |
| 501-1,000 | 3 |
| More than 1,000 | 4 |

The total width of means of egress in inches should not be less than the total occupant load served by the means of egress multiplied by 0.2 inches per occupant for stairways and by 0.15 inches per occupant for other egress components (780 CMR 1005.1 Exception 3). The table below summarizes the means of egress capacity for the building.

**Table 7 – Existing Egress Capacity**

| Floor | Exit | Stair Width (in) | Door Width (in) | Exit Capacity |
|---|---|---|---|---|
| **Level 1** | Exit next to Open Stair | N/A | 68 | 453 |
| | Cafeteria Exit | N/A | 68 | 453 |
| | Kitchen Exit | N/A | 68 | 453 |
| | (plan) West Stair Exit | 116 | 54 | 360 |
| | Exit next to Nurse | N/A | 68 | 453 |
| | (plan) West Stair Exit | N/A | 54 | 360 |
| | Exit next to Auditorium | N/A | 68 | 453 |
| | Music Room Exit | 54 | 34 | 226 |
| | **Egress Capacity Provided =** | | | **3211** |
| | **Egress Capacity Required =** | | | **1045** |
| **Level 2** | Library Exit | 60 | 68 | 300 |
| | Gymnasium Exit | 120 | 68 | 453 |
| | (plan) West Stair | 54 | 68 | 270 |
| | (plan) East Stair | 54 | 68 | 270 |
| | (plan) Southeast Stair | 44 | 34 | 220 |
| | **Egress Capacity Provided =** | | | **1513** |
| | **Egress Capacity Required =** | | | **955** |
| **Level 3** | (plan) West Stair | 54 | 68 | 270 |
| | (plan) East Stair | 54 | 68 | 270 |
| | **Egress Capacity Provided =** | | | **540** |
| | **Egress Capacity Required =** | | | **204** |

Multiple means of egress should be sized such that the loss of any one means of egress does not reduce the available capacity to less than 50 percent of the required capacity (780 CMR 1005.1). The maximum capacity required from any story of a building should be maintained to the termination of the means of egress (780 CMR 1005.1).

## 12.3. SPACES WITH ONE MEANS OF EGRESS

Two exits or exit access doorways should be provided from any newly reconfigured room or space in accordance with 780 CMR. Two means of egress are required when the single exit maximum occupant load or common path of travel are exceeded:

**Table 8 – Spaces with One Exit**

| Occupancy | Maximum Occupant Load | Common Path of Travel, Feet |
|---|---|---|
| A, E | 49 | 75 |
| B | 49 | 100 |
| S | 29 | 100 |

Where two or more exits or exit access doorways are required, the separation distance of the exit doors or exit access doorways shall not be less than one-third of the length of the maximum overall diagonal dimension of the area served (780 CMR 1015.2.1 Exception).

## 12.4. ALLOWABLE TRAVEL DISTANCES

The following table summarizes the maximum allowable dead end corridor length, common path of travel and exit access travel distance per occupancy based on 780 CMR requirements (780 CMR Table 1016.1, 1014.3 & 1018.4).

**Table 9 – Maximum Allowable Travel Distance Requirements**

| Occupancy | Dead End Distance | Common Path of Travel Distance | Travel Distance to Exit |
|---|---|---|---|
| A | 20 feet | 75 feet[6] | 250 feet |
| E | 50 feet | 75 feet[6] | 250 feet |
| B | 50 feet | 100 feet | 300 feet |
| S-2[7] | 50 feet | 100 feet | 400 feet |

## 12.5. MEANS OF EGRESS LIGHTING AND EXIT SIGNAGE

Means of egress should be provided with artificial lighting in accordance with the requirements of 780 CMR (780 CMR 102.6.4 & 1006.1). In the event of power supply failure, an emergency electrical system should automatically illuminate the following areas (780 CMR 1006.3):

- Exit access corridors, passageways and aisles in rooms and spaces which require two or more means of egress.
- Exit access corridors and exit stairways located in buildings required to have two or more exits.
- Exterior egress components at other than the level of exit discharge until exit discharge is accomplished for buildings required to have two or more exits.
- Interior exit discharge elements, as permitted in 780 CMR 1023.1, in buildings required to have two or more exits.
- The portion of the exterior exit discharge immediately adjacent to exit discharge doorways in buildings required to have two or more exits.

6 See 780 CMR 1028.8.
7 Mechanical Spaces

In emergency conditions, emergency power should be provided for a minimum of 90-minutes (780 CMR 1006.3). Emergency lighting facilities should provide an average initial illumination of one foot-candle and a minimum at any point of 0.1 foot-candle measured at any point along the path of egress at floor level. Illumination levels are permitted to decline to 60% of the initial illumination levels at the end of 90-minutes. A maximum to minimum illumination ratio of 40:1 should not be exceeded (780 CMR 1006.4).

Coverage of the normal and emergency lighting should be verified as part of this project based on the proposed configuration. During the site survey it was noted that there was insufficient exit signage in the building. Additional signage shall be provided as required for the reconfigured spaces, as described below.

In all buildings, rooms or spaces required to have more than one exit or exit access, all required means of egress should be indicated with approved signs reading “EXIT” (780 CMR 1011.1 Exception 1). Exit signs should be located at exit doors or exit access areas, and at intervening doors, so as to be readily visible; no point in an exit access corridor should be more than 100-feet from an exit sign or listed viewing distance of sign, whichever is greater (780 CMR 1011.1). The size, color and illumination of exit signs should conform to 780 CMR 1011.

## 13. STRUCTURAL

Sections 606, 707, and 807 of the 780 CMR 34 contain structural requirements that are applicable to the project. A structural evaluation of these requirements should be performed by the project’s structural engineer.

## 14. ENERGY CONSERVATION CODE

Renovations to the building are subject to compliance with the 2015 International Energy Conservation Code or the 2013 ASHRAE 90.1.

## 15. MECHANICAL

In mechanically ventilated spaces, existing mechanical ventilation systems that are altered, reconfigured, or extended are required to provide not less than 5 cubic feet per minute (cfm) per person of outdoor air and not less than 15 cfm of ventilation air per person; or not less than the amount of ventilation air determined by the Indoor Air Quality Procedure of ASHRAE 62 (780 CMR 34-709.2). All newly introduced devices, equipment, or operations that produce airborne particulate matter, odor, fumes, vapor, combustion products, gaseous contaminants, pathogenic and allergenic organisms, and microbial contaminants in such quantities as to affect adversely or impair health of cause discomfort to occupants are required to be provided with local exhaust (780 CMR 34-709.3).

## 16. PLUMBING FIXTURES

The Massachusetts Plumbing Code (248 CMR) regulates the number of plumbing fixtures required in buildings. The minimum number of plumbing fixtures is established by 248 CMR 10.10(18) Table 1 based on the building use and the anticipated program number of occupants as approved by the local Plumbing Inspector per 248 CMR 10.10(18)(a)(2). Educational facilities require separate toilet facilities for teachers and other staff employees. The following table summarizes the plumbing fixture requirements based on 248 CMR for expected occupancies within the building.

**Table 10 - Required Plumbing Fixtures**

| Fixture | 1st through 8th Grades | Faculty (Staff) | Multi-Purpose |
|---|---|---|---|
| Women's Water Closets | 1/30 | 1/20 | 1/200 |
| Men's Water Closets | 1/60 | 1/25 | 1/600 |
| Men's Urinals | 1/60 | 33% substitution | 1/200 |
| Lavatories for Each Sex | 1/60 | 1/40 | 1/200 |
| Water Fountains | 1/75 | - | - |
| Service Sinks | One Service Sink is required for each floor | | |

**The anticipated program for the building is 500 students and 50 staff. As such, a sufficient number of toilet fixtures should be allocated to both the students and staff on each floor of the building. The facilities should be located so that both student and staff men's and women's facilities are within 300-feet travel distance.**

## 17. ACCESSIBILITY

New work shall comply with 521 CMR and ADA requirements. For an alteration to an existing building where the scope of work includes an area of primary function, up to 20% of the construction cost is required to be spent on improving the accessibility with in the building (28 CFR Part 36.403(f), ADA Section 202.4). This includes providing an accessible route to the work area, access to accessible bathrooms, an accessible drinking fountain and accessible public phones (where provided). Accessibility upgrades in excess of 20% of the cost of the renovation project are considered disproportionate and would not be required by the ADA.

Alterations performed in the existing buildings are required to comply with the 2010 ADA Standards and 521 CMR. Thresholds for alterations per 521 CMR are summarized below:

- If the work costs less than $100,000, then only the work being performed is required to comply with 521 CMR (521 CMR 3.3.1 a).
- If the renovation exceeds $100,000 but is less than 30% of the full and fair cash value of the building, then the work being performed is required to comply with 521 CMR plus an accessible entrance, bathroom, drinking fountain and telephone must be provided (521 CMR 3.3.1-b).
- If the work performed, including the exempted work, amounts to 30% or more of the full and fair cash value of the building, the entire building is required to comply with 521 CMR (521 CMR 3.3.2).

The building is listed on the Town of Arlington online assessor's database as having an assessed value of $5,440,700. Based on a 0.94 assessment ratio for Arlington[8], the full and fair cash value of the building is $5,727,000. Therefore, the proposed project is expected to exceed 30% of the full and fair cash value of the building requiring the building to comply in full with 521 CMR. The following are some of the major accessibility items to that will need to be brought into compliance with 521 CMR:

[8] Proposed 2016 100% equalized valuation for the Town of Arlington, as determined by the Massachusetts Department of Revenue.

- Accessible routes, including areas where slopes are in excess of allowable slope per 521 CMR.
- All public entrances
- Drinking fountains
- Bathrooms: Note, where bathrooms are renovated, the work must be done to provide the minimum required fixtures in accordance with 248 CMR
- Elevators
- Accessible Signage
- Exterior parking
- Walkways
- Door hardware
- Ramps
- Main entrances
- Handrails for ramps and stairs

If you have any questions with respect to the above information, please do not hesitate to call us at (508) 620-8900.

## Appendix C – Transportation Evaluation Report

Memorandum

To: Regan Shields Ives, AIA, LEED AP
Principal
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Date: November 21, 2016

Project #: 13682.00

From: Vinod K. Kalikiri, PE, PTOE
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Re: Gibbs School Renovation
41 Foster Street
Arlington, Massachusetts

**TRANSPORTATION EVALUATION**

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VHB has prepared this memorandum to summarize the findings of the transportation review prepared in support of the proposed renovation and conversion of the Gibbs Center at 41 Foster Street in Arlington to the town's 6th grade public school. In addition to traffic impact analyses on area roadways, the memorandum also includes a discussion of the on-site circulation as it relates to the ability of the design to accommodate vehicular queues during the morning drop-off and afternoon pickup timeframes. The analysis is based on a total enrollment of approximately 500 students.

As detailed herein, the Project is not expected to have a major impact on area traffic operations. Limited scope traffic signal timing changes and potential re-striping of the Foster Street approach at the Massachusetts Avenue/Foster Street intersection could be considered, if determined to be necessary after occupancy, to offset the limited impacts of the Project at the signalized intersection. Alternate circulation configurations are discussed in this memorandum to identify potential factors to be considered with drop-off/pick-up operations.

The remainder of this memorandum documents the findings of the review.

## Site Location

The Site is located at 41 Foster Street, between Foster Street and Tufts Street in Arlington, Massachusetts. Figure 1 shows the Site location. The existing structure on the Site is currently home to the following educational uses:

- Arlington Center for the Arts
- Eliot Community Human Services
- Learn to Grow Day Care Center
- Lesley Ellis School
- Arlington Recreation Department's Preschool & After-School Program

## Existing Conditions

Evaluation of the transportation impacts associated with the Project requires a thorough understanding of the existing transportation conditions in the study area including, roadway geometry, traffic controls, daily and peak hour traffic flow, and traffic safety data. Each of these elements is described in detail below.

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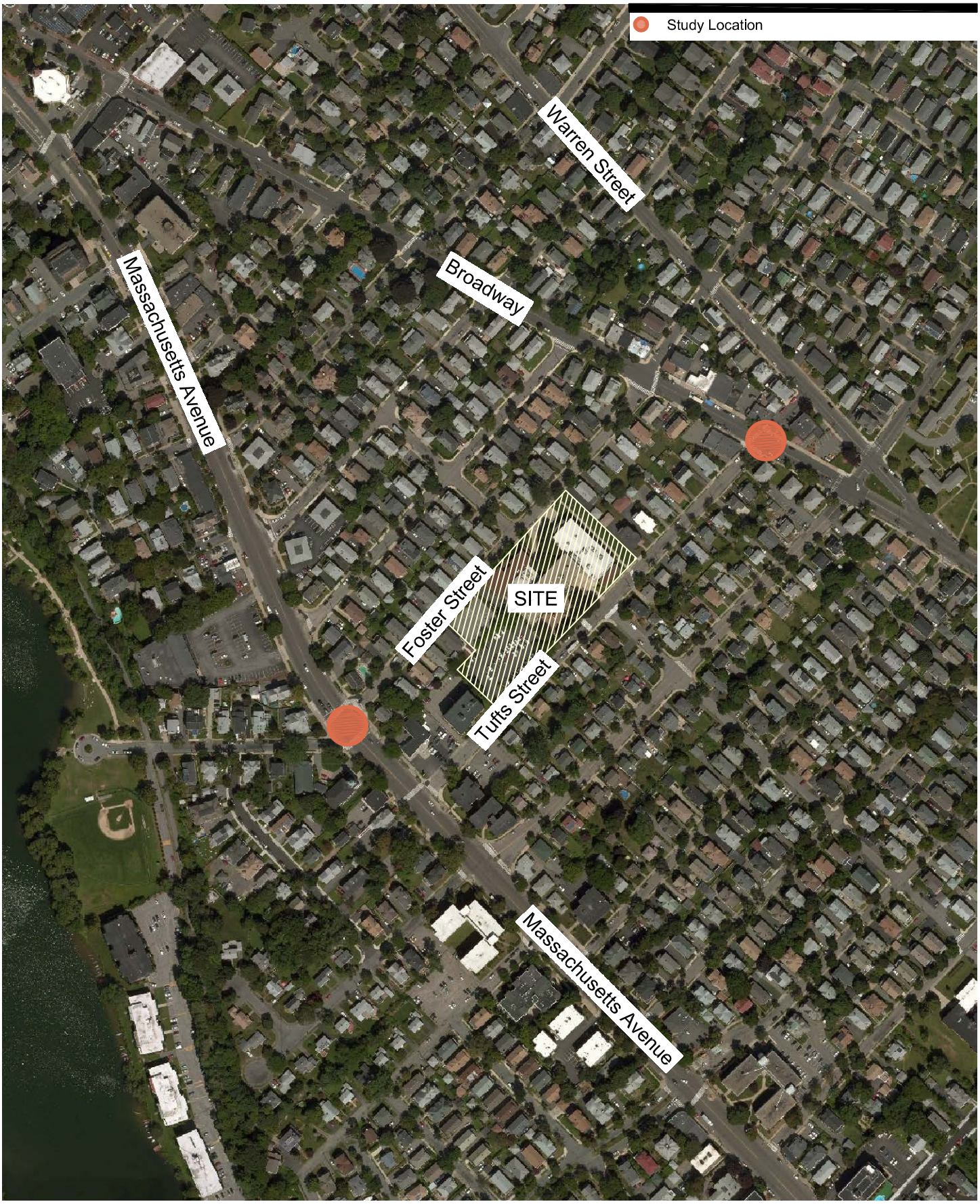


Site Location Map

**Figure 1**

The Gibbs School
Arlington, Massachusetts

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**Study Area**

Based on an understanding of the area roadway network and the expected transportation characteristics of the Project, a study area was defined to encompass roadway segments that would be used most by Project traffic. The following locations and their approaches were analyzed as part of the study.

- Broadway at Tufts Street - *unsignalized*; and
- Massachusetts Avenue at Foster Street/Linwood Street – *signalized*.

The existing conditions analysis consisted of an inventory of the traffic control, roadway, driveway and intersection geometry in the study area, observations of the school's pick-up and drop-off operations, the collection of daily and peak hour traffic volumes, and a review of recent crash history. Each of these elements is discussed in the sections below.

**Roadway Geometry**

Descriptions of the study area roadways and intersections are included below.

## Roadways

### *Foster Street*

Foster Street is a one-way local roadway that generally runs in a southbound direction. Foster Street links Massachusetts Avenue to the south with Broadway to the north. It is wide enough to operate as a two-lane roadway. However, there are no pavement markings demarcating multiple lanes. Instead, on-street parking is allowed on both sides of the roadway. The majority of the on-street parking is resident only, with a few 2-hour parking spaces adjacent to Gibbs School. Land use along the roadway, within the study area, is primarily residential with the exception of the existing educational uses at Gibbs School. There is no posted speed limit on the roadway within the study area. There are no marked bicycle accommodations on the roadway. There are pedestrian sidewalks on both sides of the roadway.

### *Tufts Street*

Tufts Street is a one-way local roadway that generally runs in a northbound direction. Tufts Street links Massachusetts Avenue to the south with Broadway and Warren Street to the north. It is wide enough to operate as a two-lane roadway. However, there are no pavement markings demarcating multiple lanes. Instead, on-street parking is allowed on both sides of the roadway. The majority of the on-street parking is resident only, with 15-minute parking spaces along the frontage of Gibbs School. Land uses along the roadway, within the study area, are primarily residential with the exception of the existing educational uses at the Gibbs School. There is no posted speed limit on the roadway within the study area. There are no marked bicycle accommodations on the street. There are pedestrian sidewalks on both sides of the roadway.





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## Intersections

### *Broadway at Tufts Street*

Tufts Street intersects Broadway from the north and south to form a four-legged unsignalized intersection. The Broadway eastbound and westbound approaches each consist of one shared general purpose lane. On-street parking is provided on both sides of the roadway. The Tufts Road northbound approach is one-way northbound and consists of one general purpose lane under STOP sign control. There is on-street parking on both sides of Tufts Street northbound. The Tufts Street southbound approach consists of one general purpose lane under STOP sign control. While the southbound approach does not have any signage indicating on-street parking, vehicles were observed to park on both sides of the roadway. There are sidewalks on both sides of all roadway approaches of the intersection, and pedestrian crosswalks exist across the eastbound, northbound and southbound approaches. Land use in the area consists of a mix of commercial and residential uses.

### *Massachusetts Avenue at Foster Street/Linwood Street*

Foster Street intersects Massachusetts Avenue from the north and Linwood Street intersects from the south to form a four-legged signalized intersection. The Massachusetts Avenue eastbound approach consists of one through lane, one shared through/right-turn lane and a bicycle lane. The Massachusetts Avenue westbound approach consists of one shared left-turn/through lane and a bicycle lane. There is on-street parking on both sides of the roadway and a MBTA bus stop on the northerly side of the roadway, to the east of the intersection. The Linwood Street northbound approach consists of one general purpose lane; on-street parking is provided on the westerly side of the roadway. The Foster Street southbound approach is one-way southbound and consists of one general purpose lane. There is on-street parking on both sides of Foster Street southbound. There are sidewalks on both sides of all four intersection approaches, and pedestrian crosswalks exist on all four approaches. An exclusive pedestrian phase is provided at the signal, activated by pedestrian push button. Land use in the area consists of a mix of commercial and residential uses.

**Student Drop-off and Pick-up Observations**

To serve as reference and background information, field observations of student drop-off activity at both the Ottoson Middle School and existing educational uses at Gibbs School were made in October 2016 to supplement related feedback provided by school staff. The observations are briefly summarized below.

## Ottoson Middle School

Field observations of the morning drop-off period were conducted from 7:00 AM to 8:30 AM on Tuesday, October 18, 2016. Observations were conducted within the School parking lot, along Acton Street, the school driveway, and Appleton Street.

Parent vehicles that arrived prior to 7:15 AM were observed to enter via Acton Street to the north, loop around the parking lot, and drop off in front of the main entrance. However, after 7:15 AM most parent vehicles entered Acton Street from the north and stopped at the turn to continue onto Acton Street towards Appleton Street. These parent vehicles were observed to stop, with up to three parent vehicles parked in parallel, blocking the intersection. Additionally, there were numerous potential conflicts that were observed between students walking to school, and


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parent vehicles stopping in the middle of the road to drop off students. A small number of parents were observed to drop-off on Appleton Place.

A number of students were observed walking from the direction of Massachusetts Avenue to the north, possibly using the MBTA bus stop located at the intersection of Massachusetts Avenue and Appleton Place.

The majority of the drop-off activity occurred between 7:30 and 7:55 AM, and all drop-off activity subsided by 8:05 as school starts at 8:07 AM. Overall, the observations of the morning drop-off peak at Ottoson School suggested that operations are currently hectic. Relocation of the 6th grade students to Gibbs School could potential help reduce some of the observed congestion.

## Gibbs School

Field observations of the existing morning drop-off period at the Gibbs School were conducted from 7:00 AM to 8:30 AM on Wednesday, October 19, 2016. Observations were conducted within the School parking lot, along Foster Street and on Tufts Street.

The existing Gibbs School is home to a number of educational and related uses, including the Lesley Ellis School and two daycare facilities. Although the uses do not necessarily have overlapping drop-off times, drop-off activity was observed to peak between 8:00 AM and 8:30 AM. Almost all of the vehicular activity for the current uses is automobile related. Generally, parents drop-off along Tufts Street, with very few parents utilizing Foster Street for drop-off. Since the majority of the students being dropped off at the currently Gibbs School are day-care age, parents were observed to park and bring students into the school. Parents were observed parking on both sides of Tufts Street. VHB observed that the parent vehicles did not fit within the 15-minute restricted parking spaces and spilled into the available resident only spaces along the roadway. Parents who arrived early were observed to park in the parking lot adjacent to the school in addition to parking on the street; however, the majority of the parking lot spaces were occupied by staff members by 8:00 AM.

Overall, the observations at Gibbs School indicated that all of the traffic associated with the 6th grade relocation will not represent new traffic to the area. In fact, VHB's observations as well as some of the traffic volume projections presented later in this memorandum suggest that a significant portion of the future school vehicular traffic in the area will be offset by the removal of the traffic associated with the existing educational uses on the Site.

**On-Site Parking**

Currently, student, staff, and visitor parking needs are accommodated on-site within the main parking lot. There are 72 striped parking spaces, including 3 handicap accessible spaces. Approximately 45 of the 72 spaces were occupied at approximately 7:45 AM; and almost all spaces were occupied by 8:15 AM.

The parking lot is signed as "Daytime Parking for Tenants and Visitors Only" for the Gibbs Center. During the peak drop-off period, parent vehicles were observed to park in the available parking spaces.




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**Roadway Traffic Volumes**

In addition to field observations of traffic and pedestrian activity and on-site circulation, VHB also conducted turning movement and classification (TMC) counts at the study area intersections during a typical weekday in October 2016 from 7:00 AM to 9:00 AM and from 2:00 PM to 4:00 PM. The weekday morning and afternoon peak periods are consistent with typical peak school traffic periods, and coincide with the peak periods for traffic entering and exiting the School. These periods represent the most critical traffic volume conditions for the purpose of this evaluation.

The roadway traffic data collected for the review was obtained during the month of October. To quantify the seasonal variation of traffic volumes in the area, historic traffic data available from MassDOT were reviewed. According to published MassDOT seasonal factors, October peak hour traffic counts are generally eight-percent higher than average month conditions. However, to present a conservative analysis, the observed peak hour traffic volumes were not reduced to reflect average month conditions. The weekday morning and afternoon 2016 Existing peak hour traffic volume networks are presented in Figure 2.

## Future Conditions

To determine the impacts of the site-generated traffic volumes on the roadways in the vicinity of the site, future traffic conditions were evaluated. A seven-year horizon (2023) was used for the evaluation to be consistent with the Massachusetts Department of Transportation's (MassDOT) traffic impact assessment guidelines.

Traffic growth on area roadways is a function of the expected land development, environmental activity, and changes in demographics. A frequently used procedure is to identify estimated traffic generated by planned developments that would be expected to affect the project study area roadways. An alternative procedure is to estimate an annual percentage increase and apply that increase to study area traffic volumes. For this evaluation, both procedures were considered. The following summarizes the traffic forecasting process.

**Traffic Growth Unrelated to the Project**

Record traffic count data was reviewed to determine the historic growth rate for traffic in the study area. While record traffic volumes on area roadways did not depict any clear growth trends (traffic volume were noted to increase some years and decrease others over the last ten years) for analysis purposes, a nominal traffic growth rate of one percent per year was used for the future condition traffic analyses to account for background growth in traffic over the next seven years.

In addition to accounting for background growth, the traffic associated with other planned and/or approved developments near the site was considered. Arlington Planning Department staff indicated that there are two development projects located on Broadway (a mixed-use project and a day-care center) but that they are located farther away from the site. Given the distance from the study area, it was determined that these projects need not be accounted for separately and that the background traffic growth assumption would cover traffic growth in the area. No other specific projects were identified that are likely to influence traffic conditions within the study area.



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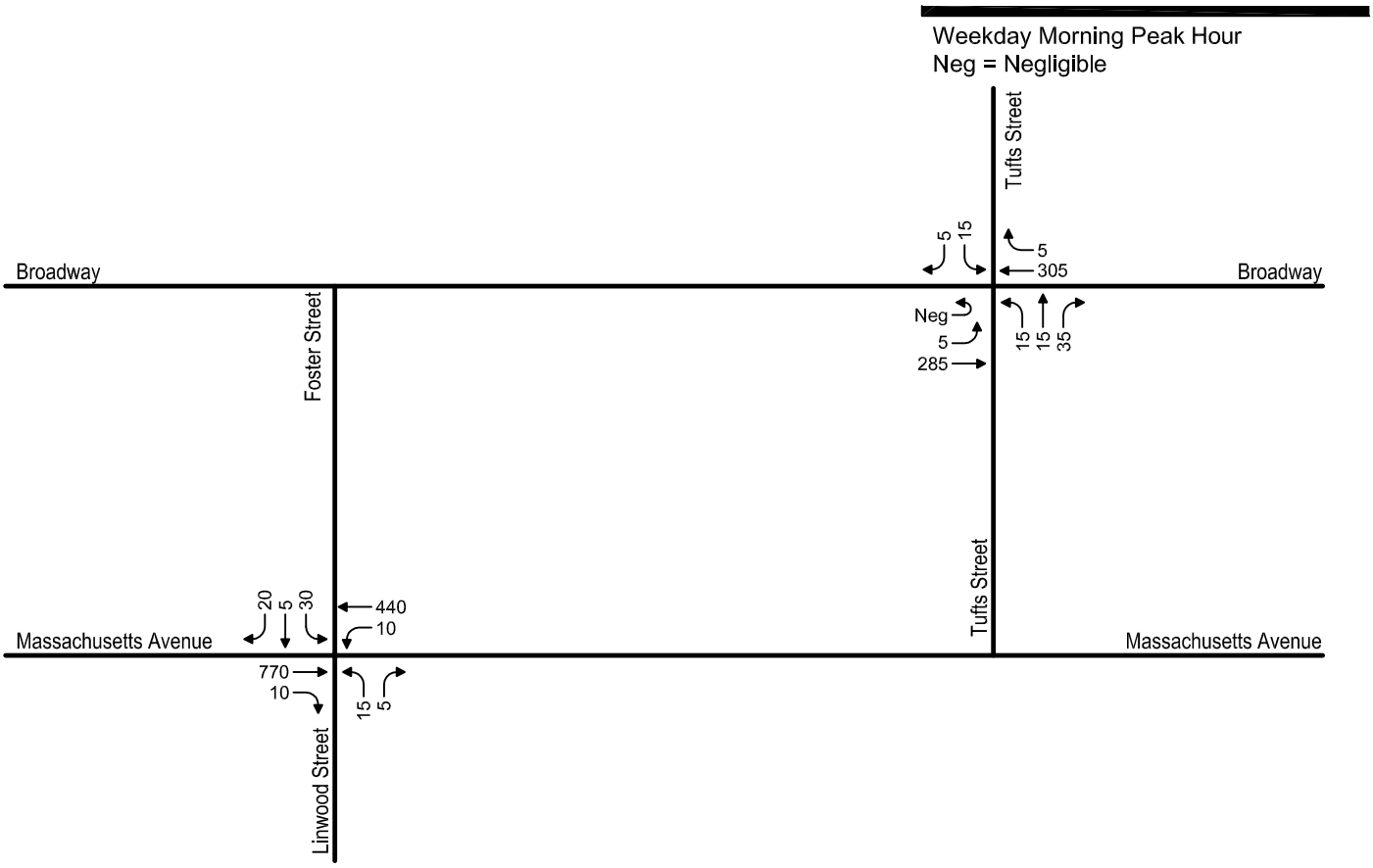


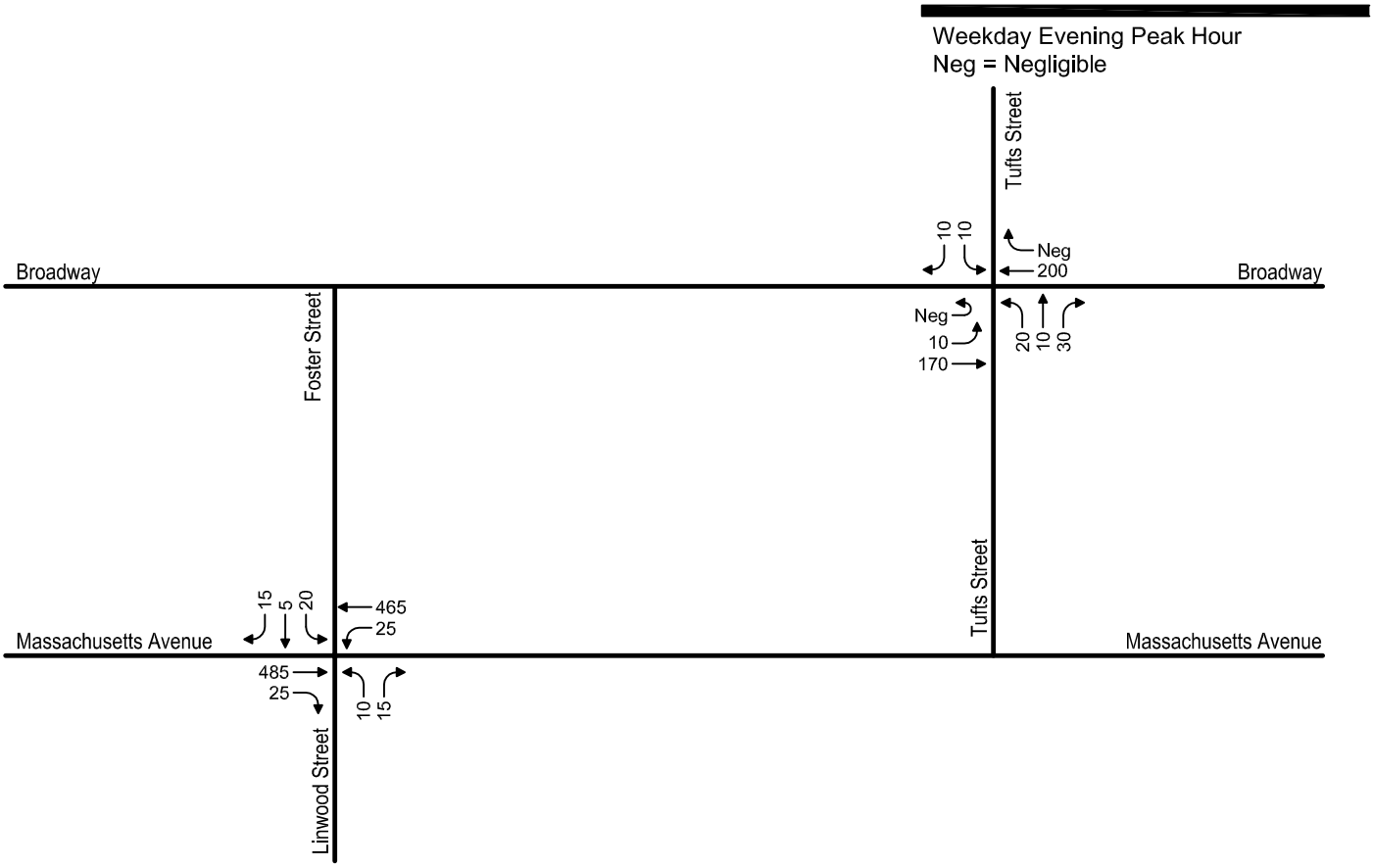


2016 Existing Traffic Volumes

**Figure 2**

The Gibbs School
Arlington, Massachusetts

November 2016

In addition to development project, proposed roadway improvements within the study area were considered. Based on discussions with the Town of Arlington, there are no planned transportation projects in the vicinity of the Site that would be implemented within the analysis horizon considered in this memorandum.

**No-Build Traffic Volumes**

The 2023 No-Build traffic volumes were generated by consideration of the above described factors. The resulting 2023 No-Build peak hour traffic volume networks are provided in Figure 3.

**Trip Generation**

The Project involves the renovation of an existing building for the Arlington Public School's 6th grade. The analysis is based on a maximum school enrollment of 500 students. Student counts, hours of operation, bussing information, and other school-specific data obtained from the school department was utilized to develop the trip generation for the school use.

Two separate trip generation analyses were conducted, one for the purpose of capacity analysis at the two study area intersections, and a second more qualitative estimate for the purpose of discussing queues and circulation at the project site. The reason for using two different methodologies is because of the differences in the way the source data used for the capacity analysis and queue analysis were originally collected. The trip generation estimates presented in this section is based upon the Institute of Transportation Engineers (ITE) guidelines and it was used for capacity analysis. The other methodology is discussed in a later section of the memorandum.

The rate at which any development generates traffic is dependent upon a number of factors such as size, location, and concentration of surrounding developments. The proposed redevelopment plan consists of the removal of the existing uses on the Site and renovation of the building into a school for Arlington Public School's 6th grade. Trip generation estimates are based on trip generation rates published by the ITE *Trip Generation, 9th Edition*[1].

The number of vehicle-trips generated by the existing schools and daycare uses (ECHS, Learn to Grow, and the Lesley Ellis School) were estimated based on ITE LUC 534 (Private School K-8) and LUC 565 (Day Care Center). To remain conservative, no trip reductions were applied to account for the removal of the existing Arlington Center for the Arts and Arlington Recreation uses. Additionally, only 75-percent of the estimated Lesley Ellis School's trips were subtracted from the roadway traffic volumes. Finally, no trip reduction was applied for ECHS during the afternoon peak hour as their pick-up time likely does not fall within the same peak period as the other uses.

Trip generation estimates for the future use was estimated based on ITE LUC 522 (Middle School/Junior High School). Table 1 summarizes the trip generation estimates.

[1] Trip Generation, 9th Edition, Institute of Transportation Engineers, Washington D.C., 2012



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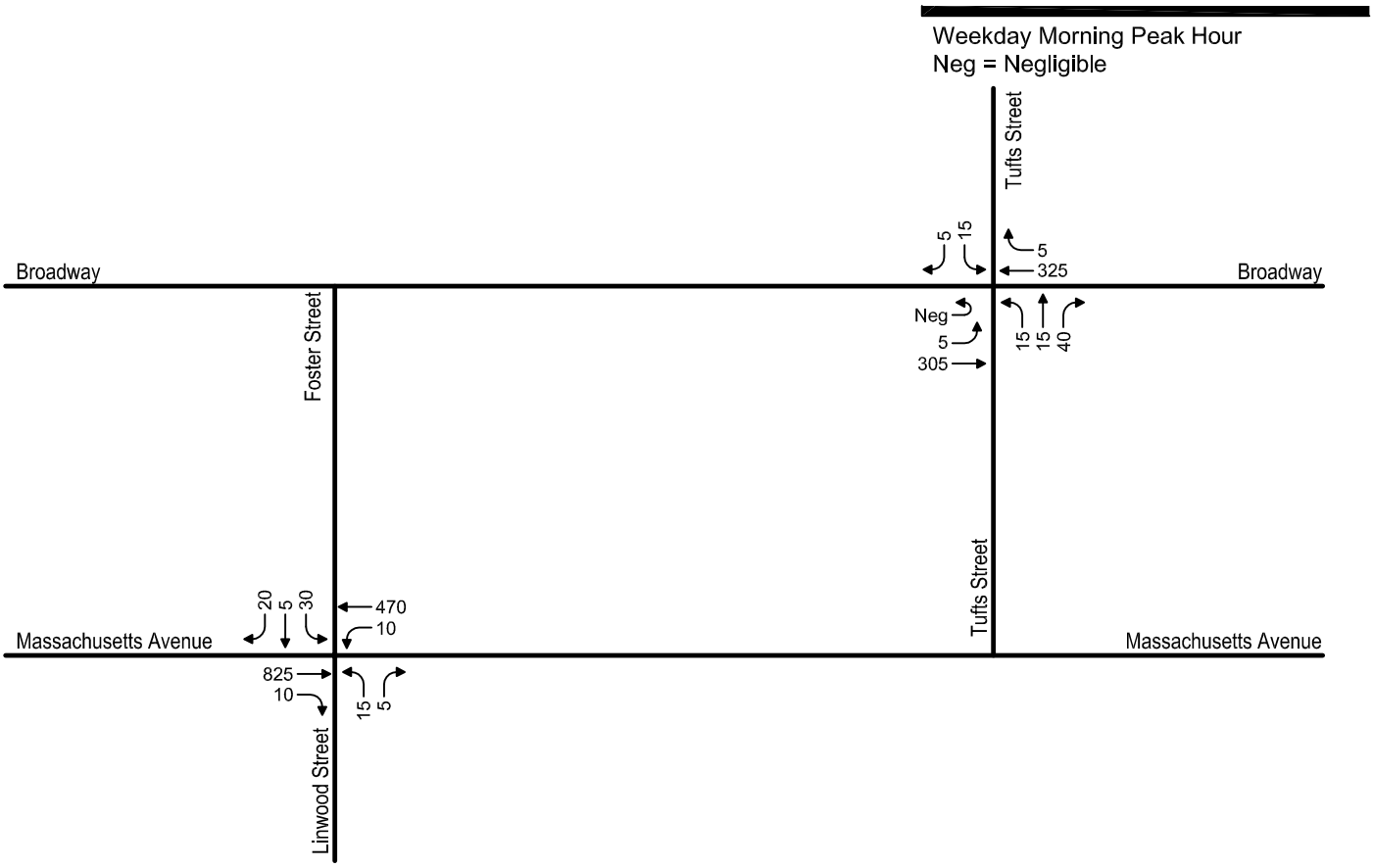


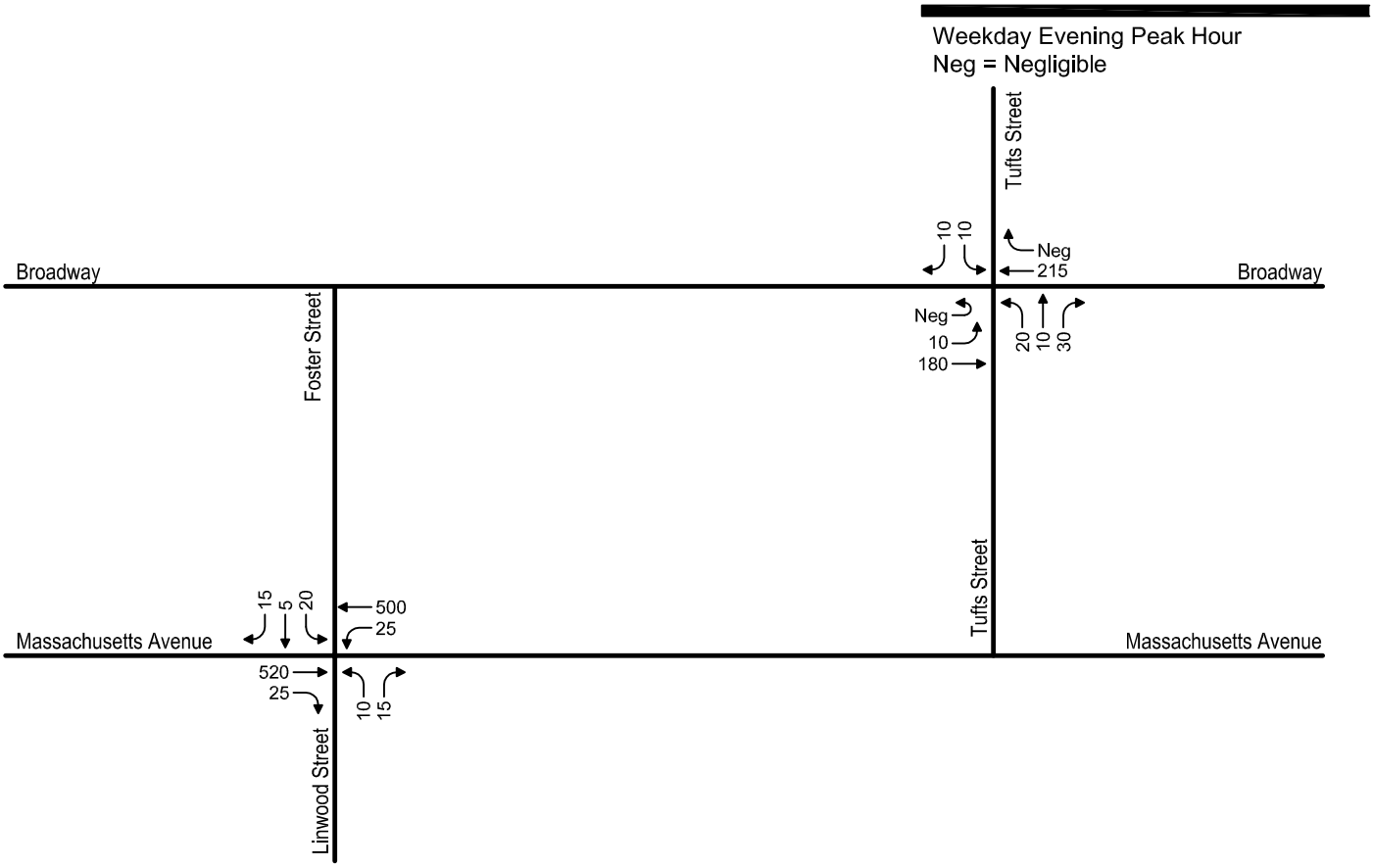


2023 No-BuildTraffic Volumes

**Figure 3**

The Gibbs School
Arlington, Massachusetts

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## Table 1: Trip Generation Summary

| Time Period | Movement | Existing Uses [a] | Proposed School [c] | Net New Trips |
|---|---|---|---|---|
| Weekday Morning | Enter | 129 | 149 | 20 |
| Peak Hour | Exit | 107 | 121 | 14 |
| | Total | 236 [a] | 270 | 34 |
| Weekday Evening | Enter | 63 | 68 | 5 |
| Peak Hour | Exit | 73 | 82 | 9 |
| | Total | 136 [b] | 150 | 14 |

a Trip generation estimate based on ITE LUC 534 (Private School K-8) for 239 students and ITE LUC 565 (Day Care Center) for 75 students, including only 75% of the Lesley Ellis School trips.
b Trip generation estimate based on 75% of ITE LUC 534 (Private School K-8) for 174 students and ITE LUC 565 (Day Care Center) for 75 students
c Trip generation estimate based on ITE LUC 522 (Middle School/Junior High School) for 500 students

As shown in Table 1, the current uses on the Site which predominantly rely on personal automobile mode of travel are estimated to be generating significant amount of traffic. Subtracting the existing trip estimate from the estimated future trip generation for the 6th grade will result in approximately an additional 34 weekday morning peak hour trips (20 entering/14 exiting) and 14 weekday evening peak hour trips (5 entering/9 exiting) on the area roadways.

It is noted that the information in the ITE trip generation database, which is essentially a compilation of vehicle counts at other existing schools in the country, inherently accounts for trip reductions associated with bus, bicycle/pedestrian modes of travel. No separate trip adjustments were therefore applied to the ITE estimates for the purpose of the developing trip estimates that will be used for capacity analyses.

**Trip Distribution**

The directional distribution of traffic approaching and departing the Site will be based on potential drop-off and pick-up procedures (which are currently still under development/refinement). The directional distribution of traffic approaching and departing the general area via the area roadway network will be based on the number of current 2nd, 3rd and 4th grade students living in each precinct in Arlington who will be the target population for the Site in the future.

The current Site Plan depicts a main entrance and a student waiting/refuge area on Foster Street. While it would be desirable for the majority of the parent drop-off and pick-up to occur on Foster Street, the length of Foster Street may not accommodate the projected maximum queues especially during inclement weather conditions when automobile mode of travel can be expected to be much higher than fair weather conditions. Consequently, as part of this analysis, VHB analyzed the potential for parents forming two queues for drop-off and pick-up; one on southbound Foster


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Street and the other, potentially within the parking with access from Tufts Street (this configuration is shown in Figure A-3 in the attachment to this memorandum). This allows for queueing to be split between two different streets/approaches and still allow all vehicles to exit onto Foster Street. Alternate configurations are discussed in the circulation and queuing section.

Based on a review of the GIS precinct data for student residences and the location of Gibbs School within the town, approximately 80-percent of the trips can be expected to be oriented towards the west. Based on the proposed circulation and drop-off/pick-up plan, the entering trips will be split between Tufts Street and Foster Street, with all of the exiting trips using Foster Street. The trip distribution patterns estimated for the Project, which was developed based on a combination of precinct locations for student residences and roadway traffic volumes, are presented in Table 2.

## Table 2: Trip Distribution

| | | Morning Peak Hour | | Afternoon Peak Hour | |
|---|---|---|---|---|---|
| **Travel Route** | **Direction (to/from)** | **Entering** | **Exiting** | **Entering** | **Exiting** |
| Massachusetts Avenue | East | 10% | 75% | 10% | 20% |
| | West | 40% | 25% | 40% | 80% |
| Broadway | East | 10% | 0% | 10% | 0% |
| | West | 40% | 0% | 40% | 0% |
| Total | | 100% | 100% | 100% | 100% |

### Build Traffic Volumes

The site-generated traffic volumes were assigned to the roadway network according to the distribution and travel patterns described above, and added to the No-Build traffic volumes to develop the peak hour Build traffic volume networks. Figure 4 presents the resulting 2023 Build traffic volumes for the weekday morning and weekday evening peak hours.

### Traffic Operations Analysis

To assess quality of flow, intersection capacity analyses were conducted with respect to 2016 Existing, 2023 No-Build, and 2023 Build traffic volume conditions. The evaluation criteria used to analyze area intersections and roadways in this traffic study are based on the 2010 Highway Capacity Manual (HCM). Tables 3 and 4 summarize the capacity analysis results for the signalized and unsignalized study locations, respectively.





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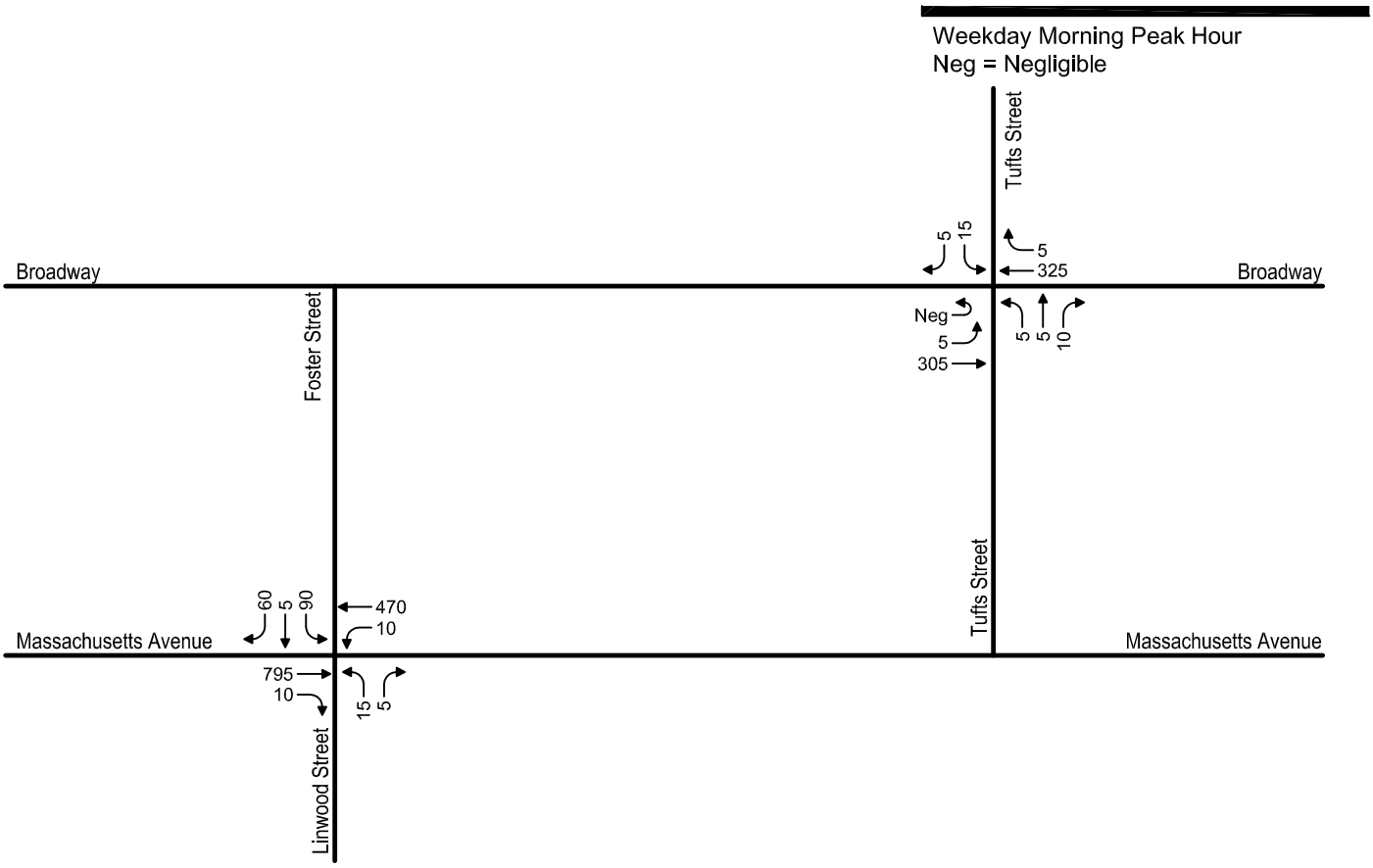


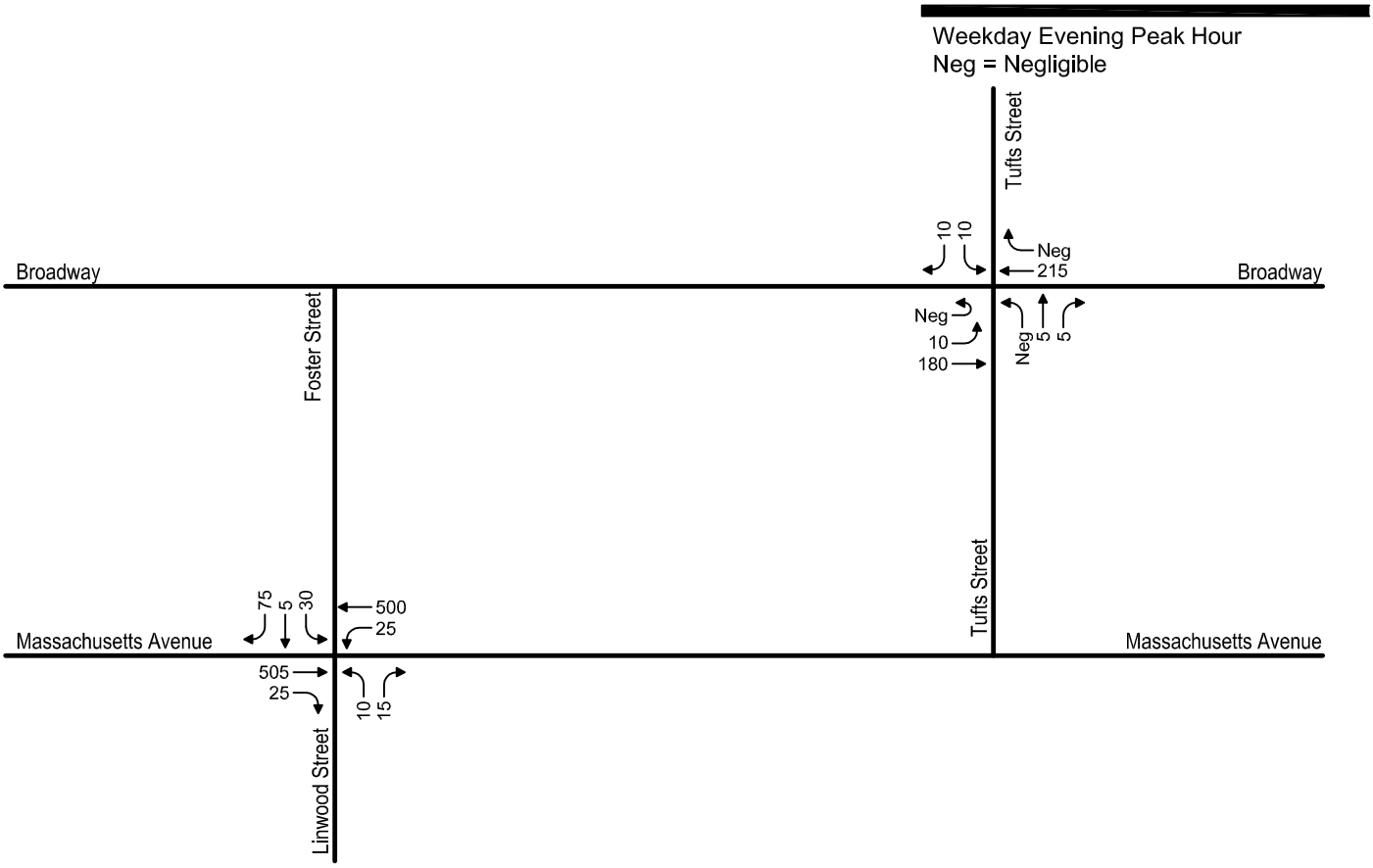


2023 Build Traffic Volumes

**Figure 4**

The Gibbs School
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## Table 3: Signalized Intersection Capacity Analysis

| Location / Movement | 2016 Existing Conditions | | | | | 2023 No-Build Conditions | | | | | 2023 Build Conditions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | v/c [a] | Del [b] | LOS [c] | 50 Q [d] | 95 Q [e] | v/c | Del | LOS | 50 Q | 95 Q | v/c | Del | LOS | 50 Q | 95 Q |
| **Massachusetts Avenue at Foster Street/ Linwood Street** | | | | | | | | | | | | | | | |
| *Weekday Morning* | | | | | | | | | | | | | | | |
| EB TR | 0.34 | 10 | A | 159 | 201 | 0.37 | 10 | A | 180 | 225 | 0.39 | 10 | B | 171 | 215 |
| WB LT | 0.40 | 11 | B | 197 | 275 | 0.71 | 12 | B | 207 | 293 | 0.45 | 12 | B | 207 | 293 |
| NB LR | 0.12 | 8 | A | 0 | 13 | 0.09 | 8 | A | 0 | 13 | 0.14 | 8 | A | 0 | 13 |
| SB LTR | 0.44 | 51 | D | 36 | 81 | 0.09 | 50 | D | 34 | 79 | >1.20 | >120 | F | ~149 | #291 |
| **Overall** | | **12** | **B** | | | | **12** | **B** | | | | **28** | **C** | | |
| *Weekday Evening* | | | | | | | | | | | | | | | |
| EB TR | 0.25 | 10 | A | 100 | 128 | 0.26 | 10 | A | 103 | 135 | 0.27 | 10 | A | 100 | 131 |
| WB LT | 0.47 | 14 | B | 224 | 313 | 0.48 | 14 | B | 237 | 335 | 0.52 | 15 | B | 237 | 335 |
| NB LR | 0.20 | 16 | B | 0 | 18 | 0.16 | 12 | B | 0 | 21 | 0.18 | 12 | B | 0 | 21 |
| SB LTR | 0.37 | 47 | D | 29 | 56 | 0.29 | 43 | D | 21 | 58 | 0.66 | 49 | D | 51 | #135 |
| **Overall** | | **13** | **B** | | | | **13** | **B** | | | | **16** | **B** | | |

a. Volume to capacity ratio
b. Average total delay, in seconds per vehicle
c. Level-of-service
d. 50th percentile queue, in feet
e. 95th percentile queue, in feet

~ Volume exceeds capacity, queue cannot be calculated accurately
# 95th percentile volume exceeds capacity, queue cannot be calculated accurately

## Table 4: Unsignalized Intersection Capacity Analysis

| Location / Movement | 2016 Existing Conditions | | | | | 2023 No-Build Conditions | | | | | 2023 Build Conditions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D [a] | v/c [b] | Del [c] | LOS [d] | 95 Q [e] | D | v/c | Del | LOS | 95 Q | D | v/c | Del | LOS | 95 Q |
| **Broadway at Tufts Street** | | | | | | | | | | | | | | | |
| *Weekday Morning* | | | | | | | | | | | | | | | |
| EB L | 5 | 0.01 | 8 | A | 0 | 5 | 0.01 | 8 | A | 0 | 5 | 0.01 | 8 | A | 0 |
| NB LTR | 65 | 0.26 | 16 | C | 25 | 70 | 0.16 | 14 | B | 13 | 20 | 0.05 | 13 | B | 5 |
| SB L/R | 20 | 0.12 | 20 | C | 10 | 20 | 0.06 | 16 | C | 5 | 20 | 0.06 | 15 | C | 10 |
| *Weekday Evening* | | | | | | | | | | | | | | | |
| EB L | 10 | 0.01 | 8 | A | 0 | 10 | 0.01 | 8 | A | 0 | 10 | 0.01 | 8 | A | 0 |
| NB LTR | 60 | 0.12 | 12 | B | 10 | 60 | 0.11 | 12 | B | 10 | 10 | 0.02 | 12 | B | 3 |
| SB L/R | 20 | 0.06 | 12 | B | 5 | 20 | 0.04 | 12 | B | 3 | 20 | 0.04 | 12 | B | 3 |

a Demand = vehicles per hour
b v/c = volume to capacity ratio
c delay = average intersection delay, measured in seconds
d LOS = level-of-service
e 95th percentile queue

The tabulated results for the signalized intersection of Massachusetts Avenue/Foster Street/Linwood Street indicate that while the Project generates relatively low additional traffic volumes in comparison to the current educational uses on the Site, shifting the primary drop-off/pick-up to the Foster Street side of the building, and thereby requiring almost all exiting vehicles to travel through the traffic signal, could cause congested operations for the southbound


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left turn movement on Foster Street at the traffic signal. Potential limited scope improvement at the signalized intersection are outlined for further consideration to improve the projected operational deficiency.

## Potential Improvements for Further Consideration

The Foster Street one-way southbound approach is approximately 26-feet wide, which is wide enough to accommodate two egress lanes, although it is not striped for two lanes. If on-street parking is restricted for the last 75- to 100-feet of Foster Street and the pavement restriped to allow for a shared left-turn/through lane and a right-turn lane, the revised lane configuration would allow for the Foster Street signal phase to process more vehicles during each signal cycle than with a single lane, which will help improve the traffic operations for the approach. Concurrently, the traffic signal timings at the intersection could also be adjusted slightly to balance the green time between the Massachusetts Avenue and Foster Street to further enhance operations, especially during the weekday morning peak hour. Table 5 summarizes the capacity analysis results with and without these changes.

## Table 5: Signalized Intersection Capacity Analysis with Improvements

| Location / | 2023 No-Build Conditions | | | | | 2023 Build Conditions | | | | | 2023 Build Conditions with Improvements | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | v/c [a] | Del [b] | LOS [c] | 50 Q [d] | 95 Q [e] | v/c | Del | LOS | 50 Q | 95 Q | v/c | Del | LOS | 50 Q | 95 Q |
| **Massachusetts Avenue at Foster Street/ Linwood Street** | | | | | | | | | | | | | | | |
| *Weekday Morning* | | | | | | | | | | | | | | | |
| EB TR | 0.37 | 10 | A | 180 | 225 | 0.39 | 10 | B | 171 | 215 | 0.40 | 12 | B | 184 | 230 |
| WB LT | 0.71 | 12 | B | 207 | 293 | 0.45 | 12 | B | 207 | 293 | 0.46 | 14 | B | 222 | 314 |
| NB LR | 0.09 | 8 | A | 0 | 13 | 0.14 | 8 | A | 0 | 13 | 0.11 | 7 | A | 0 | 12 |
| SB LTR | 0.09 | 50 | D | 34 | 79 | >1.20 | >120 | F | ~149 | #291 | | | n/a | | |
| SB LT | | | n/a | | | | | n/a | | | 0.65 | 69 | E | 78 | #164 |
| SB R | | | n/a | | | | | n/a | | | 0.28 | 15 | B | 0 | 43 |
| **Overall** | | **12** | **B** | | | | **28** | **C** | | | | **16** | **B** | | |
| *Weekday Evening* | | | | | | | | | | | | | | | |
| EB TR | 0.26 | 10 | A | 103 | 135 | 0.27 | 10 | A | 100 | 131 | 0.27 | 10 | A | 100 | 131 |
| WB LT | 0.48 | 14 | B | 237 | 335 | 0.52 | 15 | B | 237 | 335 | 0.52 | 15 | B | 237 | 335 |
| NB LR | 0.16 | 12 | B | 0 | 21 | 0.18 | 12 | B | 0 | 21 | 0.16 | 12 | B | 0 | 21 |
| SB LTR | 0.29 | 43 | D | 21 | 58 | 0.66 | 49 | D | 51 | #135 | | | n/a | | |
| SB LT | | | n/a | | | | | n/a | | | 0.31 | 57 | E | 27 | 63 |
| SB R | | | n/a | | | | | n/a | | | 0.38 | 16 | B | 0 | 49 |
| **Overall** | | **13** | **B** | | | | **16** | **B** | | | | **14** | **B** | | |

a. Volume to capacity ratio
b. Average total delay, in seconds per vehicle
c. Level-of-service
d. 50th percentile queue, in feet
e. 95th percentile queue, in feet

~ Volume exceeds capacity, queue cannot be calculated accurately
# 95th percentile volume exceeds capacity, queue cannot be calculated accurately

Other factors to be considered relative to the above noted potential improvement is the availability of signal heads within the cones of vision for the two separate lanes, and adding another signal head if determined to be necessary; potential changes to vehicle detection on Foster Street to accommodate separate lanes; and, any additional signage related improvements to support the changes to the lane configuration. While such improvements can be considered prior to the occupancy of the school, since the analysis presented in this memorandum is based on estimated traffic


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volumes, a possible alternate approach to handling physical changes at the intersection would be to observe actual traffic flow after occupancy, and consider the improvements as part of the post-construction adjustments.

## Circulation and Vehicle Queuing

As discussed earlier, the current Site Plan depicts a main entrance and a student waiting/refuge area on Foster Street. The plan shows the elimination of the parking lot vehicular connection to Foster Street that currently exists. However, the traffic review presented in this memorandum indicates that while it may be desirable to handle all parent drop-off and pick-up on one-street, estimated queues associated with such an operation, as discussed in this section, may require the consideration of alternative circulation and queuing configuration.

The location of the main entrance on Foster Street, and a lack of a vehicular connection between Tufts Street and Foster Street through the school parking lot, will likely lead to two scenarios:

1. Parents arriving via Massachusetts Avenue may ignore the direction to drop-off on Foster Street and choose to drop off students on the Tufts Street side of the school; or,
2. If the drop-off/pick-up requirement on Foster Street is strictly enforced, the vehicular queues on the roadway may get excessively long, which may lead to alternate and sometimes less desirable outcomes such as parents dropping off students on both sides of the Foster Street resulting in students crossing the street between parked and moving vehicles.

As an attachment to this memorandum, VHB has prepared three graphics depicting alternate pickup/drop-off configurations for Gibbs School, and the associated factors that need to be considered when evaluating each of them. The graphics are based on the queue estimates presented below.

The Town of Arlington provided VHB with precinct data for the current 2nd, 3rd, and 4th grade students, who are expected to be the first three classes of 6th graders at the new Gibbs School after it opens in 2018. Based on the data reviewed, approximately 38-percent of the students (or 190 students out of 500) are eligible to take the bus. Approximately 25-percent (or 125 students) are within the half mile radius who would likely walk/bike to school during favorable weather conditions. Based on this information, two alternatives queue estimates are shown in Table 7 below. Both scenarios assume a total enrollment of 500 students, with a combination of assumptions relative to walk/bike/bus mode of travel.





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## Table 6 Vehicle Queue Estimates

| | Favorable Weather Conditions (Lower Auto Mode of Travel) | Poor Weather Conditions (Higher Auto Mode of Travel) |
|---|---|---|
| % Students Bussed | 38% | 19% |
| # Students Bussed | 190 | 95 |
| % Students Walking | 25% | 10% |
| # Students Walking | 190 | 50 |
| **Net Students** | **185** | **355** |
| | | |
| **Average Queue** | **320' (16 cars)** | **600' (30 cars)** |
| **High Demand Queue** | **415' (21 cars)** | **780' (39 cars)** |

As shown in Table 6, the school can expect queues in the order of 16 to 21 cars under favorable weather condition, with higher proportion of non-personal automobile modes of travel. This estimate assumes that all of the students eligible for the bus will take it and most of the students within a reasonable walking distance will walk to and from school. The alternate analysis for poor weather conditions assumes that only half the students eligible for the bus would take it and less than half of the students within walking distance would walk, resulting in queues in the order of 30 to 39 vehicles. For comparison, the length of Foster Street upstream of the end of the playground is approximately 735 feet (=36 vehicles) beyond which there is a potential for queue spill back onto Broadway.

The three graphics included in the attachment to this memorandum depict the factors to be considered for alternate drop-off/pick-up configurations that are available. Following are some of the items notes on the graphics.

- On-street drop-off/pick-up will require that parking restrictions be implemented on the street during school peaks.
- Drop-off/pick-up on Foster Street involves parent vehicles pulling up alongside the curb, with the passenger side of the car on the street side.
- Drop-off on both sides of the street will involve students crossing the street in between cars which is not desirable.
- During the afternoon pick-up, there is a potential for the queue problems to be exacerbated if parents are queued on the street before dismissal, and pick-up occurs along the full length of the roadway rather than at a defined location in front of the school.
- Finally, available queue storage may be affected depending on the efficiency of snow removal on the street.

Measures that could be considered to help reduce the queue impacts include promotion of higher usage of buses by reducing the two-mile radius limitation for bus eligibility, development of a system for carpooling, directing parents to queue on Tufts Street if they arrive prior to dismissal and limiting pick-up only in front of the school building rather than along the full length of the roadway.



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# Attachments

- Traffic Count Data
- Seasonal Adjustment Factors
- Background Growth
- Trip Generation
- Trip Distribution
- Capacity Analysis Worksheets
- Queue Figures

# Traffic Count Data

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 A
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars - Heavy Vehicles**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 104 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 39 | 0 | 0 | 1 | 0 | 3 | 0 | 154 |
| 06:45 AM | 2 | 106 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 57 | 1 | 0 | 1 | 0 | 2 | 0 | 175 |
| Total | 2 | 210 | 0 | 0 | 2 | 0 | 11 | 0 | 0 | 96 | 1 | 0 | 2 | 0 | 5 | 0 | 329 |
| 07:00 AM | 2 | 155 | 0 | 0 | 3 | 0 | 10 | 0 | 0 | 60 | 2 | 0 | 1 | 0 | 1 | 0 | 234 |
| 07:15 AM | 1 | 204 | 0 | 0 | 4 | 0 | 8 | 0 | 0 | 93 | 0 | 0 | 0 | 0 | 1 | 0 | 311 |
| 07:30 AM | 2 | 206 | 0 | 0 | 4 | 2 | 6 | 0 | 0 | 118 | 2 | 0 | 2 | 0 | 4 | 0 | 346 |
| 07:45 AM | 0 | 186 | 0 | 0 | 5 | 2 | 7 | 0 | 0 | 125 | 1 | 0 | 1 | 0 | 4 | 0 | 331 |
| Total | 5 | 751 | 0 | 0 | 16 | 4 | 31 | 0 | 0 | 396 | 5 | 0 | 4 | 0 | 10 | 0 | 1222 |
| 08:00 AM | 6 | 199 | 0 | 0 | 3 | 1 | 8 | 0 | 0 | 87 | 4 | 0 | 2 | 0 | 4 | 0 | 314 |
| 08:15 AM | 4 | 180 | 0 | 0 | 7 | 1 | 7 | 0 | 0 | 111 | 2 | 0 | 2 | 0 | 3 | 0 | 317 |
| Grand Total | 17 | 1340 | 0 | 0 | 28 | 6 | 57 | 0 | 0 | 690 | 12 | 0 | 10 | 0 | 22 | 0 | 2182 |
| Apprch % | 1.3 | 98.7 | 0 | 0 | 30.8 | 6.6 | 62.6 | 0 | 0 | 98.3 | 1.7 | 0 | 31.2 | 0 | 68.8 | 0 | |
| Total % | 0.8 | 61.4 | 0 | 0 | 1.3 | 0.3 | 2.6 | 0 | 0 | 31.6 | 0.5 | 0 | 0.5 | 0 | 1 | 0 | |
| Cars | 16 | 1274 | 0 | 0 | 28 | 6 | 53 | 0 | 0 | 646 | 11 | 0 | 10 | 0 | 22 | 0 | 2066 |
| % Cars | 94.1 | 95.1 | 0 | 0 | 100 | 100 | 93 | 0 | 0 | 93.6 | 91.7 | 0 | 100 | 0 | 100 | 0 | 94.7 |
| Heavy Vehicles | 1 | 66 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 44 | 1 | 0 | 0 | 0 | 0 | 0 | 116 |
| % Heavy Vehicles | 5.9 | 4.9 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 6.4 | 8.3 | 0 | 0 | 0 | 0 | 0 | 5.3 |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 2 | 206 | 0 | 0 | 208 | 4 | 2 | 6 | 0 | 12 | 0 | 118 | 2 | 0 | 120 | 2 | 0 | 4 | 0 | 6 | 346 |
| 07:45 AM | 0 | 186 | 0 | 0 | 186 | 5 | 2 | 7 | 0 | 14 | 0 | 125 | 1 | 0 | 126 | 1 | 0 | 4 | 0 | 5 | 331 |
| 08:00 AM | 6 | 199 | 0 | 0 | 205 | 3 | 1 | 8 | 0 | 12 | 0 | 87 | 4 | 0 | 91 | 2 | 0 | 4 | 0 | 6 | 314 |
| 08:15 AM | 4 | 180 | 0 | 0 | 184 | 7 | 1 | 7 | 0 | 15 | 0 | 111 | 2 | 0 | 113 | 2 | 0 | 3 | 0 | 5 | 317 |
| Total Volume | 12 | 771 | 0 | 0 | 783 | 19 | 6 | 28 | 0 | 53 | 0 | 441 | 9 | 0 | 450 | 7 | 0 | 15 | 0 | 22 | 1308 |
| % App. Total | 1.5 | 98.5 | 0 | 0 | | 35.8 | 11.3 | 52.8 | 0 | | 0 | 98 | 2 | 0 | | 31.8 | 0 | 68.2 | 0 | | |
| PHF | .500 | .936 | .000 | .000 | .941 | .679 | .750 | .875 | .000 | .883 | .000 | .882 | .563 | .000 | .893 | .875 | .000 | .938 | .000 | .917 | .945 |
| Cars | 11 | 735 | 0 | 0 | 746 | 19 | 6 | 27 | 0 | 52 | 0 | 413 | 8 | 0 | 421 | 7 | 0 | 15 | 0 | 22 | 1241 |
| % Cars | 91.7 | 95.3 | 0 | 0 | 95.3 | 100 | 100 | 96.4 | 0 | 98.1 | 0 | 93.7 | 88.9 | 0 | 93.6 | 100 | 0 | 100 | 0 | 100 | 94.9 |
| Heavy Vehicles | 1 | 36 | 0 | 0 | 37 | 0 | 0 | 1 | 0 | 1 | 0 | 28 | 1 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 67 |
| % Heavy Vehicles | 8.3 | 4.7 | 0 | 0 | 4.7 | 0 | 0 | 3.6 | 0 | 1.9 | 0 | 6.3 | 11.1 | 0 | 6.4 | 0 | 0 | 0 | 0 | 0 | 5.1 |

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 A
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 100 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 38 | 0 | 0 | 1 | 0 | 3 | 0 | 149 |
| 06:45 AM | 2 | 98 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 55 | 1 | 0 | 1 | 0 | 2 | 0 | 165 |
| Total | 2 | 198 | 0 | 0 | 2 | 0 | 11 | 0 | 0 | 93 | 1 | 0 | 2 | 0 | 5 | 0 | 314 |
| 07:00 AM | 2 | 145 | 0 | 0 | 3 | 0 | 8 | 0 | 0 | 55 | 2 | 0 | 1 | 0 | 1 | 0 | 217 |
| 07:15 AM | 1 | 196 | 0 | 0 | 4 | 0 | 7 | 0 | 0 | 85 | 0 | 0 | 0 | 0 | 1 | 0 | 294 |
| 07:30 AM | 2 | 195 | 0 | 0 | 4 | 2 | 5 | 0 | 0 | 111 | 1 | 0 | 2 | 0 | 4 | 0 | 326 |
| 07:45 AM | 0 | 181 | 0 | 0 | 5 | 2 | 7 | 0 | 0 | 116 | 1 | 0 | 1 | 0 | 4 | 0 | 317 |
| Total | 5 | 717 | 0 | 0 | 16 | 4 | 27 | 0 | 0 | 367 | 4 | 0 | 4 | 0 | 10 | 0 | 1154 |
| 08:00 AM | 6 | 189 | 0 | 0 | 3 | 1 | 8 | 0 | 0 | 82 | 4 | 0 | 2 | 0 | 4 | 0 | 299 |
| 08:15 AM | 3 | 170 | 0 | 0 | 7 | 1 | 7 | 0 | 0 | 104 | 2 | 0 | 2 | 0 | 3 | 0 | 299 |
| Grand Total | 16 | 1274 | 0 | 0 | 28 | 6 | 53 | 0 | 0 | 646 | 11 | 0 | 10 | 0 | 22 | 0 | 2066 |
| Apprch % | 1.2 | 98.8 | 0 | 0 | 32.2 | 6.9 | 60.9 | 0 | 0 | 98.3 | 1.7 | 0 | 31.2 | 0 | 68.8 | 0 | |
| Total % | 0.8 | 61.7 | 0 | 0 | 1.4 | 0.3 | 2.6 | 0 | 0 | 31.3 | 0.5 | 0 | 0.5 | 0 | 1.1 | 0 | |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 2 | 195 | 0 | 0 | 197 | 4 | 2 | 5 | 0 | 11 | 0 | 111 | 1 | 0 | 112 | 2 | 0 | 4 | 0 | 6 | 326 |
| 07:45 AM | 0 | 181 | 0 | 0 | 181 | 5 | 2 | 7 | 0 | 14 | 0 | 116 | 1 | 0 | 117 | 1 | 0 | 4 | 0 | 5 | 317 |
| 08:00 AM | 6 | 189 | 0 | 0 | 195 | 3 | 1 | 8 | 0 | 12 | 0 | 82 | 4 | 0 | 86 | 2 | 0 | 4 | 0 | 6 | 299 |
| 08:15 AM | 3 | 170 | 0 | 0 | 173 | 7 | 1 | 7 | 0 | 15 | 0 | 104 | 2 | 0 | 106 | 2 | 0 | 3 | 0 | 5 | 299 |
| Total Volume | 11 | 735 | 0 | 0 | 746 | 19 | 6 | 27 | 0 | 52 | 0 | 413 | 8 | 0 | 421 | 7 | 0 | 15 | 0 | 22 | 1241 |
| % App. Total | 1.5 | 98.5 | 0 | 0 | | 36.5 | 11.5 | 51.9 | 0 | | 0 | 98.1 | 1.9 | 0 | | 31.8 | 0 | 68.2 | 0 | | |
| PHF | .458 | .942 | .000 | .000 | .947 | .679 | .750 | .844 | .000 | .867 | .000 | .890 | .500 | .000 | .900 | .875 | .000 | .938 | .000 | .917 | .952 |

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 A
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Heavy Vehicles**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 06:45 AM | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Total | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 07:00 AM | 0 | 10 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| 07:15 AM | 0 | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| 07:30 AM | 0 | 11 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 20 |
| 07:45 AM | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| Total | 0 | 34 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 29 | 1 | 0 | 0 | 0 | 0 | 0 | 68 |
| 08:00 AM | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 08:15 AM | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| Grand Total | 1 | 66 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 44 | 1 | 0 | 0 | 0 | 0 | 0 | 116 |
| Apprch % | 1.5 | 98.5 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 97.8 | 2.2 | 0 | 0 | 0 | 0 | 0 | |
| Total % | 0.9 | 56.9 | 0 | 0 | 0 | 0 | 3.4 | 0 | 0 | 37.9 | 0.9 | 0 | 0 | 0 | 0 | 0 | |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:00 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:00 AM | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 17 |
| 07:15 AM | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 1 | 0 | 1 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 17 |
| 07:30 AM | 0 | 11 | 0 | 0 | 11 | 0 | 0 | 1 | 0 | 1 | 0 | 7 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 20 |
| 07:45 AM | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 14 |
| Total Volume | 0 | 34 | 0 | 0 | 34 | 0 | 0 | 4 | 0 | 4 | 0 | 29 | 1 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 68 |
| % App. Total | 0 | 100 | 0 | 0 | | 0 | 0 | 100 | 0 | | 0 | 96.7 | 3.3 | 0 | | 0 | 0 | 0 | 0 | | |
| PHF | .000 | .773 | .000 | .000 | .773 | .000 | .000 | .500 | .000 | .500 | .000 | .806 | .250 | .000 | .833 | .000 | .000 | .000 | .000 | .000 | .850 |

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

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Email: datarequests@pdillc.com

File Name : 165320 A
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Peds and Bikes**

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | Right | Thru | Left | Peds SB | Peds NB | Right | Thru | Left | Peds WB | Peds EB | Right | Thru | Left | Peds NB | Peds SB | Int. Total |
| 06:30 AM | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 10 |
| 06:45 AM | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 11 |
| Total | 0 | 1 | 0 | 0 | 4 | 0 | 1 | 0 | 2 | 2 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | 2 | 21 |
| 07:00 AM | 1 | 5 | 0 | 1 | 3 | 0 | 3 | 1 | 5 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 27 |
| 07:15 AM | 5 | 8 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 25 |
| 07:30 AM | 1 | 7 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| 07:45 AM | 3 | 7 | 0 | 1 | 3 | 0 | 5 | 0 | 2 | 1 | 0 | 4 | 0 | 4 | 1 | 2 | 0 | 0 | 2 | 1 | 36 |
| Total | 10 | 27 | 0 | 4 | 8 | 0 | 11 | 1 | 7 | 4 | 0 | 14 | 1 | 9 | 4 | 2 | 0 | 0 | 2 | 4 | 108 |
| 08:00 AM | 2 | 14 | 0 | 1 | 5 | 0 | 4 | 0 | 1 | 1 | 0 | 3 | 1 | 3 | 6 | 1 | 0 | 1 | 5 | 1 | 49 |
| 08:15 AM | 2 | 19 | 0 | 3 | 6 | 0 | 4 | 0 | 6 | 2 | 0 | 3 | 1 | 0 | 3 | 2 | 0 | 0 | 5 | 0 | 56 |
| Grand Total | 14 | 61 | 0 | 8 | 23 | 0 | 20 | 1 | 16 | 9 | 0 | 24 | 3 | 13 | 13 | 5 | 0 | 1 | 16 | 7 | 234 |
| Apprch % | 13.2 | 57.5 | 0 | 7.5 | 21.7 | 0 | 43.5 | 2.2 | 34.8 | 19.6 | 0 | 45.3 | 5.7 | 24.5 | 24.5 | 17.2 | 0 | 3.4 | 55.2 | 24.1 | |
| Total % | 6 | 26.1 | 0 | 3.4 | 9.8 | 0 | 8.5 | 0.4 | 6.8 | 3.8 | 0 | 10.3 | 1.3 | 5.6 | 5.6 | 2.1 | 0 | 0.4 | 6.8 | 3 | |

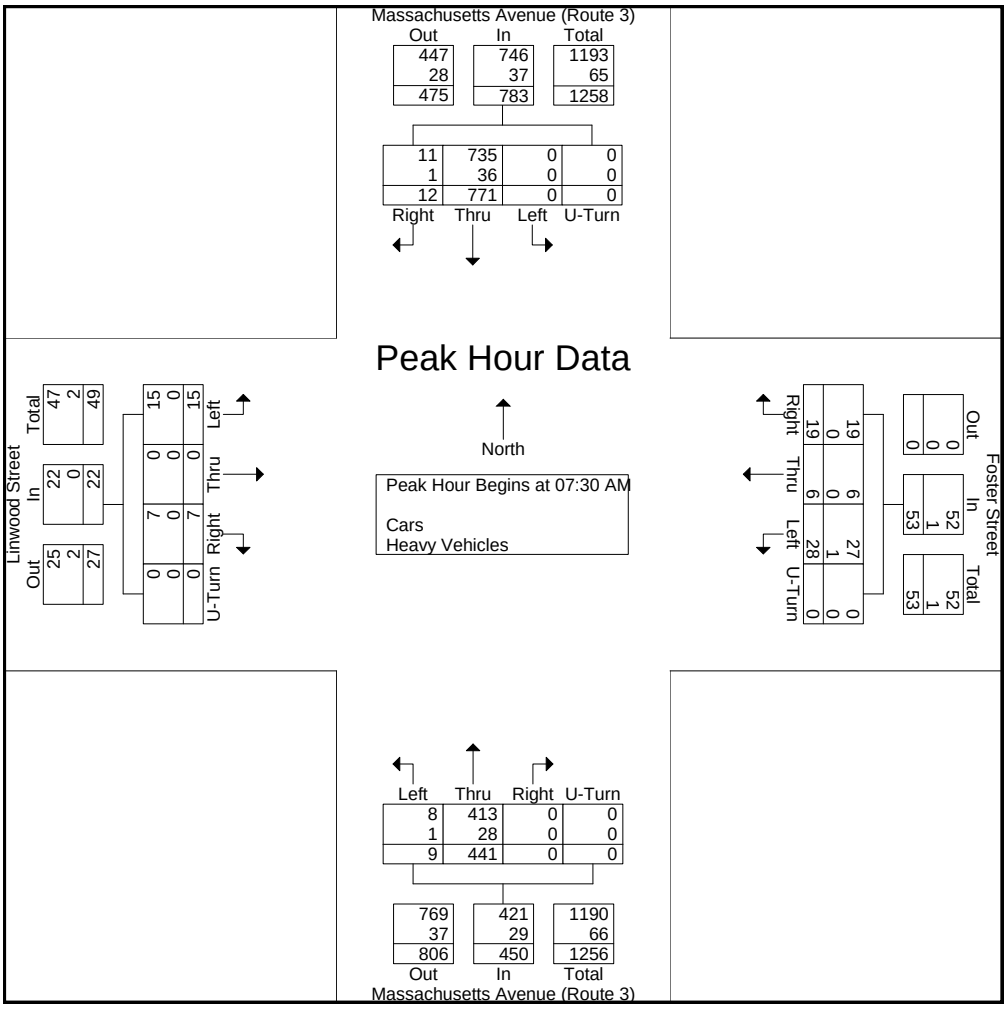
| | Massachusetts Avenue (Route 3) From North | | | | | | Foster Street From East | | | | | | Massachusetts Avenue (Route 3) From South | | | | | | Linwood Street From West | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | App. Total | Right | Thru | Left | Peds SB | Peds NB | App. Total | Right | Thru | Left | Peds WB | Peds EB | App. Total | Right | Thru | Left | Peds NB | Peds SB | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 1 | 7 | 0 | 1 | 2 | 11 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 6 | 1 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| 07:45 AM | 3 | 7 | 0 | 1 | 3 | 14 | 0 | 5 | 0 | 2 | 1 | 8 | 0 | 4 | 0 | 4 | 1 | 9 | 2 | 0 | 0 | 2 | 1 | 5 | 36 |
| 08:00 AM | 2 | 14 | 0 | 1 | 5 | 22 | 0 | 4 | 0 | 1 | 1 | 6 | 0 | 3 | 1 | 3 | 6 | 13 | 1 | 0 | 1 | 5 | 1 | 8 | 49 |
| 08:15 AM | 2 | 19 | 0 | 3 | 6 | 30 | 0 | 4 | 0 | 6 | 2 | 12 | 0 | 3 | 1 | 0 | 3 | 7 | 2 | 0 | 0 | 5 | 0 | 7 | 56 |
| Total Volume | 8 | 47 | 0 | 6 | 16 | 77 | 0 | 13 | 0 | 9 | 5 | 27 | 0 | 16 | 3 | 8 | 10 | 37 | 5 | 0 | 1 | 12 | 2 | 20 | 161 |
| % App. Total | 10.4 | 61 | 0 | 7.8 | 20.8 | | 0 | 48.1 | 0 | 33.3 | 18.5 | | 0 | 43.2 | 8.1 | 21.6 | 27 | | 25 | 0 | 5 | 60 | 10 | | |
| PHF | .667 | .618 | .000 | .500 | .667 | .642 | .000 | .650 | .000 | .375 | .625 | .563 | .000 | .667 | .750 | .500 | .417 | .712 | .625 | .000 | .250 | .600 | .500 | .625 | .719 |

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 A
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 2 | 206 | 0 | 0 | 208 | 4 | 2 | 6 | 0 | 12 | 0 | 118 | 2 | 0 | 120 | 2 | 0 | 4 | 0 | 6 | 346 |
| 07:45 AM | 0 | 186 | 0 | 0 | 186 | 5 | 2 | 7 | 0 | 14 | 0 | 125 | 1 | 0 | 126 | 1 | 0 | 4 | 0 | 5 | 331 |
| 08:00 AM | 6 | 199 | 0 | 0 | 205 | 3 | 1 | 8 | 0 | 12 | 0 | 87 | 4 | 0 | 91 | 2 | 0 | 4 | 0 | 6 | 314 |
| 08:15 AM | 4 | 180 | 0 | 0 | 184 | 7 | 1 | 7 | 0 | 15 | 0 | 111 | 2 | 0 | 113 | 2 | 0 | 3 | 0 | 5 | 317 |
| Total Volume | 12 | 771 | 0 | 0 | 783 | 19 | 6 | 28 | 0 | 53 | 0 | 441 | 9 | 0 | 450 | 7 | 0 | 15 | 0 | 22 | 1308 |
| % App. Total | 1.5 | 98.5 | 0 | 0 | | 35.8 | 11.3 | 52.8 | 0 | | 0 | 98 | 2 | 0 | | 31.8 | 0 | 68.2 | 0 | | |
| PHF | .500 | .936 | .000 | .000 | .941 | .679 | .750 | .875 | .000 | .883 | .000 | .882 | .563 | .000 | .893 | .875 | .000 | .938 | .000 | .917 | .945 |
| Cars | 11 | 735 | 0 | 0 | 746 | 19 | 6 | 27 | 0 | 52 | 0 | 413 | 8 | 0 | 421 | 7 | 0 | 15 | 0 | 22 | 1241 |
| % Cars | 91.7 | 95.3 | 0 | 0 | 95.3 | 100 | 100 | 96.4 | 0 | 98.1 | 0 | 93.7 | 88.9 | 0 | 93.6 | 100 | 0 | 100 | 0 | 100 | 94.9 |
| Heavy Vehicles | 1 | 36 | 0 | 0 | 37 | 0 | 0 | 1 | 0 | 1 | 0 | 28 | 1 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 67 |
| % Heavy Vehicles | 8.3 | 4.7 | 0 | 0 | 4.7 | 0 | 0 | 3.6 | 0 | 1.9 | 0 | 6.3 | 11.1 | 0 | 6.4 | 0 | 0 | 0 | 0 | 0 | 5.1 |



N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 AA
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars - Heavy Vehicles**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 1 | 107 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 104 | 2 | 0 | 4 | 0 | 1 | 0 | 222 |
| 02:15 PM | 4 | 114 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 128 | 3 | 0 | 3 | 0 | 3 | 0 | 258 |
| 02:30 PM | 1 | 133 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 138 | 3 | 0 | 1 | 0 | 0 | 0 | 281 |
| 02:45 PM | 4 | 135 | 0 | 0 | 3 | 0 | 5 | 0 | 0 | 124 | 5 | 0 | 1 | 0 | 5 | 0 | 282 |
| Total | 10 | 489 | 0 | 0 | 7 | 1 | 11 | 0 | 0 | 494 | 13 | 0 | 9 | 0 | 9 | 0 | 1043 |
| 03:00 PM | 7 | 114 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 111 | 0 | 0 | 4 | 0 | 2 | 0 | 245 |
| 03:15 PM | 4 | 120 | 0 | 0 | 7 | 1 | 6 | 0 | 0 | 109 | 5 | 0 | 2 | 0 | 5 | 0 | 259 |
| 03:30 PM | 6 | 113 | 0 | 0 | 6 | 0 | 5 | 0 | 0 | 128 | 7 | 0 | 4 | 0 | 5 | 0 | 274 |
| 03:45 PM | 7 | 137 | 0 | 0 | 4 | 1 | 5 | 0 | 0 | 119 | 2 | 0 | 5 | 0 | 0 | 0 | 280 |
| Total | 24 | 484 | 0 | 0 | 17 | 3 | 22 | 0 | 0 | 467 | 14 | 0 | 15 | 0 | 12 | 0 | 1058 |
| Grand Total | 34 | 973 | 0 | 0 | 24 | 4 | 33 | 0 | 0 | 961 | 27 | 0 | 24 | 0 | 21 | 0 | 2101 |
| Apprch % | 3.4 | 96.6 | 0 | 0 | 39.3 | 6.6 | 54.1 | 0 | 0 | 97.3 | 2.7 | 0 | 53.3 | 0 | 46.7 | 0 | |
| Total % | 1.6 | 46.3 | 0 | 0 | 1.1 | 0.2 | 1.6 | 0 | 0 | 45.7 | 1.3 | 0 | 1.1 | 0 | 1 | 0 | |
| Cars | 33 | 926 | 0 | 0 | 23 | 4 | 32 | 0 | 0 | 907 | 27 | 0 | 24 | 0 | 21 | 0 | 1997 |
| % Cars | 97.1 | 95.2 | 0 | 0 | 95.8 | 100 | 97 | 0 | 0 | 94.4 | 100 | 0 | 100 | 0 | 100 | 0 | 95 |
| Heavy Vehicles | 1 | 47 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 104 |
| % Heavy Vehicles | 2.9 | 4.8 | 0 | 0 | 4.2 | 0 | 3 | 0 | 0 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | | | | | |
| 02:30 PM | 1 | 133 | 0 | 0 | 134 | 0 | 1 | 4 | 0 | 5 | 0 | 138 | 3 | 0 | 141 | 1 | 0 | 0 | 0 | 1 | 281 |
| 02:45 PM | 4 | 135 | 0 | 0 | 139 | 3 | 0 | 5 | 0 | 8 | 0 | 124 | 5 | 0 | 129 | 1 | 0 | 5 | 0 | 6 | 282 |
| 03:00 PM | 7 | 114 | 0 | 0 | 121 | 0 | 1 | 6 | 0 | 7 | 0 | 111 | 0 | 0 | 111 | 4 | 0 | 2 | 0 | 6 | 245 |
| 03:15 PM | 4 | 120 | 0 | 0 | 124 | 7 | 1 | 6 | 0 | 14 | 0 | 109 | 5 | 0 | 114 | 2 | 0 | 5 | 0 | 7 | 259 |
| Total Volume | 16 | 502 | 0 | 0 | 518 | 10 | 3 | 21 | 0 | 34 | 0 | 482 | 13 | 0 | 495 | 8 | 0 | 12 | 0 | 20 | 1067 |
| % App. Total | 3.1 | 96.9 | 0 | 0 | | 29.4 | 8.8 | 61.8 | 0 | | 0 | 97.4 | 2.6 | 0 | | 40 | 0 | 60 | 0 | | |
| PHF | .571 | .930 | .000 | .000 | .932 | .357 | .750 | .875 | .000 | .607 | .000 | .873 | .650 | .000 | .878 | .500 | .000 | .600 | .000 | .714 | .946 |
| Cars | 16 | 477 | 0 | 0 | 493 | 10 | 3 | 20 | 0 | 33 | 0 | 455 | 13 | 0 | 468 | 8 | 0 | 12 | 0 | 20 | 1014 |
| % Cars | 100 | 95.0 | 0 | 0 | 95.2 | 100 | 100 | 95.2 | 0 | 97.1 | 0 | 94.4 | 100 | 0 | 94.5 | 100 | 0 | 100 | 0 | 100 | 95.0 |
| Heavy Vehicles | 0 | 25 | 0 | 0 | 25 | 0 | 0 | 1 | 0 | 1 | 0 | 27 | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 53 |
| % Heavy Vehicles | 0 | 5.0 | 0 | 0 | 4.8 | 0 | 0 | 4.8 | 0 | 2.9 | 0 | 5.6 | 0 | 0 | 5.5 | 0 | 0 | 0 | 0 | 0 | 5.0 |

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Client: VHB/ C. Trearchis

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Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 AA
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 1 | 99 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 100 | 2 | 0 | 4 | 0 | 1 | 0 | 210 |
| 02:15 PM | 4 | 112 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 119 | 3 | 0 | 3 | 0 | 3 | 0 | 246 |
| 02:30 PM | 1 | 127 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 130 | 3 | 0 | 1 | 0 | 0 | 0 | 267 |
| 02:45 PM | 4 | 131 | 0 | 0 | 3 | 0 | 4 | 0 | 0 | 115 | 5 | 0 | 1 | 0 | 5 | 0 | 268 |
| Total | 10 | 469 | 0 | 0 | 6 | 1 | 10 | 0 | 0 | 464 | 13 | 0 | 9 | 0 | 9 | 0 | 991 |
| 03:00 PM | 7 | 106 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 105 | 0 | 0 | 4 | 0 | 2 | 0 | 231 |
| 03:15 PM | 4 | 113 | 0 | 0 | 7 | 1 | 6 | 0 | 0 | 105 | 5 | 0 | 2 | 0 | 5 | 0 | 248 |
| 03:30 PM | 6 | 107 | 0 | 0 | 6 | 0 | 5 | 0 | 0 | 120 | 7 | 0 | 4 | 0 | 5 | 0 | 260 |
| 03:45 PM | 6 | 131 | 0 | 0 | 4 | 1 | 5 | 0 | 0 | 113 | 2 | 0 | 5 | 0 | 0 | 0 | 267 |
| Total | 23 | 457 | 0 | 0 | 17 | 3 | 22 | 0 | 0 | 443 | 14 | 0 | 15 | 0 | 12 | 0 | 1006 |
| Grand Total | 33 | 926 | 0 | 0 | 23 | 4 | 32 | 0 | 0 | 907 | 27 | 0 | 24 | 0 | 21 | 0 | 1997 |
| Apprch % | 3.4 | 96.6 | 0 | 0 | 39 | 6.8 | 54.2 | 0 | 0 | 97.1 | 2.9 | 0 | 53.3 | 0 | 46.7 | 0 | |
| Total % | 1.7 | 46.4 | 0 | 0 | 1.2 | 0.2 | 1.6 | 0 | 0 | 45.4 | 1.4 | 0 | 1.2 | 0 | 1.1 | 0 | |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | | | | | |
| 02:30 PM | 1 | 127 | 0 | 0 | 128 | 0 | 1 | 4 | 0 | 5 | 0 | 130 | 3 | 0 | 133 | 1 | 0 | 0 | 0 | 1 | 267 |
| 02:45 PM | 4 | 131 | 0 | 0 | 135 | 3 | 0 | 4 | 0 | 7 | 0 | 115 | 5 | 0 | 120 | 1 | 0 | 5 | 0 | 6 | 268 |
| 03:00 PM | 7 | 106 | 0 | 0 | 113 | 0 | 1 | 6 | 0 | 7 | 0 | 105 | 0 | 0 | 105 | 4 | 0 | 2 | 0 | 6 | 231 |
| 03:15 PM | 4 | 113 | 0 | 0 | 117 | 7 | 1 | 6 | 0 | 14 | 0 | 105 | 5 | 0 | 110 | 2 | 0 | 5 | 0 | 7 | 248 |
| Total Volume | 16 | 477 | 0 | 0 | 493 | 10 | 3 | 20 | 0 | 33 | 0 | 455 | 13 | 0 | 468 | 8 | 0 | 12 | 0 | 20 | 1014 |
| % App. Total | 3.2 | 96.8 | 0 | 0 | | 30.3 | 9.1 | 60.6 | 0 | | 0 | 97.2 | 2.8 | 0 | | 40 | 0 | 60 | 0 | | |
| PHF | .571 | .910 | .000 | .000 | .913 | .357 | .750 | .833 | .000 | .589 | .000 | .875 | .650 | .000 | .880 | .500 | .000 | .600 | .000 | .714 | .946 |

N/S: Massachusetts Avenue (Route 3)
E/W: Foster Street/ Linwood Street
City, State: Arlington, MA
Client: VHB/ C. Trearchis

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Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 AA
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Heavy Vehicles**

| | Massachusetts Avenue (Route 3) From North | | | | Foster Street From East | | | | Massachusetts Avenue (Route 3) From South | | | | Linwood Street From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 02:15 PM | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 02:30 PM | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 02:45 PM | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| Total | 0 | 20 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 52 |
| 03:00 PM | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 03:15 PM | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 03:30 PM | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 03:45 PM | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| Total | 1 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 52 |
| Grand Total | 1 | 47 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 104 |
| Apprch % | 2.1 | 97.9 | 0 | 0 | 50 | 0 | 50 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total % | 1 | 45.2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 51.9 | 0 | 0 | 0 | 0 | 0 | 0 | |

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:15 PM | | | | | | | | | | | | | | | | | | | | | |
| 02:15 PM | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 12 |
| 02:30 PM | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 14 |
| 02:45 PM | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 14 |
| 03:00 PM | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 14 |
| Total Volume | 0 | 20 | 0 | 0 | 20 | 1 | 0 | 1 | 0 | 2 | 0 | 32 | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 54 |
| % App. Total | 0 | 100 | 0 | 0 | | 50 | 0 | 50 | 0 | | 0 | 100 | 0 | 0 | | 0 | 0 | 0 | 0 | | |
| PHF | .000 | .625 | .000 | .000 | .625 | .250 | .000 | .250 | .000 | .500 | .000 | .889 | .000 | .000 | .889 | .000 | .000 | .000 | .000 | .000 | .964 |

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**Groups Printed- Peds and Bikes**

| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | Right | Thru | Left | Peds SB | Peds NB | Right | Thru | Left | Peds WB | Peds EB | Right | Thru | Left | Peds NB | Peds SB | Int. Total |
| 02:00 PM | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| 02:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 5 | 15 |
| 02:30 PM | 0 | 3 | 0 | 1 | 3 | 0 | 1 | 0 | 5 | 5 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 7 | 3 | 31 |
| 02:45 PM | 0 | 3 | 0 | 5 | 4 | 0 | 1 | 0 | 4 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 8 | 4 | 32 |
| Total | 0 | 6 | 0 | 8 | 9 | 0 | 2 | 0 | 13 | 12 | 0 | 6 | 0 | 2 | 2 | 1 | 0 | 0 | 18 | 12 | 91 |
| 03:00 PM | 1 | 3 | 0 | 5 | 2 | 0 | 1 | 0 | 6 | 4 | 0 | 3 | 0 | 3 | 4 | 0 | 0 | 0 | 3 | 4 | 39 |
| 03:15 PM | 0 | 0 | 0 | 4 | 5 | 0 | 0 | 0 | 5 | 4 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 6 | 4 | 33 |
| 03:30 PM | 0 | 4 | 0 | 3 | 6 | 0 | 0 | 0 | 2 | 0 | 0 | 5 | 0 | 6 | 0 | 0 | 0 | 0 | 5 | 7 | 38 |
| 03:45 PM | 0 | 2 | 0 | 6 | 4 | 0 | 0 | 0 | 8 | 4 | 0 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 4 | 6 | 40 |
| Total | 1 | 9 | 0 | 18 | 17 | 0 | 1 | 0 | 21 | 12 | 0 | 13 | 1 | 13 | 4 | 1 | 0 | 0 | 18 | 21 | 150 |
| Grand Total | 1 | 15 | 0 | 26 | 26 | 0 | 3 | 0 | 34 | 24 | 0 | 19 | 1 | 15 | 6 | 2 | 0 | 0 | 36 | 33 | 241 |
| Apprch % | 1.5 | 22.1 | 0 | 38.2 | 38.2 | 0 | 4.9 | 0 | 55.7 | 39.3 | 0 | 46.3 | 2.4 | 36.6 | 14.6 | 2.8 | 0 | 0 | 50.7 | 46.5 | |
| Total % | 0.4 | 6.2 | 0 | 10.8 | 10.8 | 0 | 1.2 | 0 | 14.1 | 10 | 0 | 7.9 | 0.4 | 6.2 | 2.5 | 0.8 | 0 | 0 | 14.9 | 13.7 | |

| | Massachusetts Avenue (Route 3) From North | | | | | | Foster Street From East | | | | | | Massachusetts Avenue (Route 3) From South | | | | | | Linwood Street From West | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | App. Total | Right | Thru | Left | Peds SB | Peds NB | App. Total | Right | Thru | Left | Peds WB | Peds EB | App. Total | Right | Thru | Left | Peds NB | Peds SB | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 03:00 PM | | | | | | | | | | | | | | | | | | | | | | | | | |
| 03:00 PM | 1 | 3 | 0 | 5 | 2 | 11 | 0 | 1 | 0 | 6 | 4 | 11 | 0 | 3 | 0 | 3 | 4 | 10 | 0 | 0 | 0 | 3 | 4 | 7 | 39 |
| 03:15 PM | 0 | 0 | 0 | 4 | 5 | 9 | 0 | 0 | 0 | 5 | 4 | 9 | 0 | 3 | 0 | 2 | 0 | 5 | 0 | 0 | 0 | 6 | 4 | 10 | 33 |
| 03:30 PM | 0 | 4 | 0 | 3 | 6 | 13 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 6 | 0 | 11 | 0 | 0 | 0 | 5 | 7 | 12 | 38 |
| 03:45 PM | 0 | 2 | 0 | 6 | 4 | 12 | 0 | 0 | 0 | 8 | 4 | 12 | 0 | 2 | 1 | 2 | 0 | 5 | 1 | 0 | 0 | 4 | 6 | 11 | 40 |
| Total Volume | 1 | 9 | 0 | 18 | 17 | 45 | 0 | 1 | 0 | 21 | 12 | 34 | 0 | 13 | 1 | 13 | 4 | 31 | 1 | 0 | 0 | 18 | 21 | 40 | 150 |
| % App. Total | 2.2 | 20 | 0 | 40 | 37.8 | | 0 | 2.9 | 0 | 61.8 | 35.3 | | 0 | 41.9 | 3.2 | 41.9 | 12.9 | | 2.5 | 0 | 0 | 45 | 52.5 | | |
| PHF | .250 | .563 | .000 | .750 | .708 | .865 | .000 | .250 | .000 | .656 | .750 | .708 | .000 | .650 | .250 | .542 | .250 | .705 | .250 | .000 | .000 | .750 | .750 | .833 | .938 |

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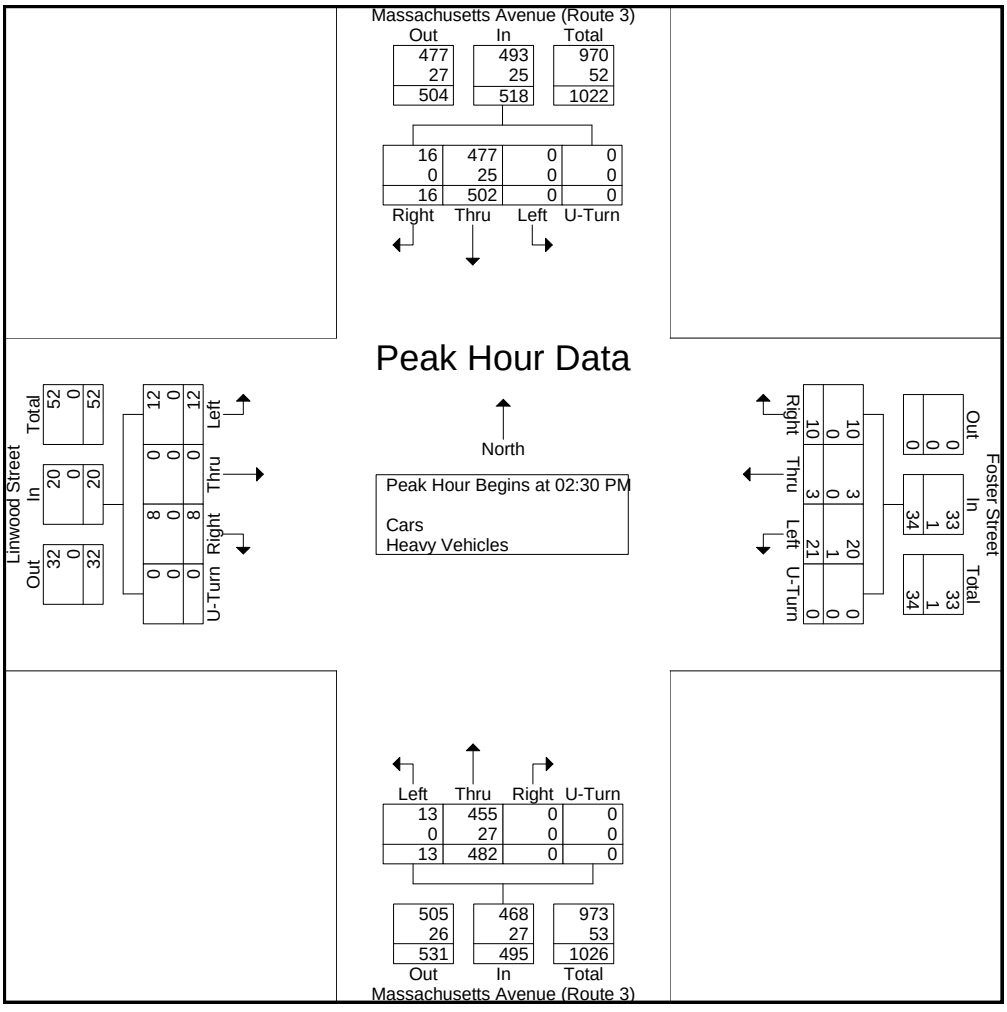
| | Massachusetts Avenue (Route 3) From North | | | | | Foster Street From East | | | | | Massachusetts Avenue (Route 3) From South | | | | | Linwood Street From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | | | | | |
| 02:30 PM | 1 | 133 | 0 | 0 | 134 | 0 | 1 | 4 | 0 | 5 | 0 | 138 | 3 | 0 | 141 | 1 | 0 | 0 | 0 | 1 | 281 |
| 02:45 PM | 4 | 135 | 0 | 0 | 139 | 3 | 0 | 5 | 0 | 8 | 0 | 124 | 5 | 0 | 129 | 1 | 0 | 5 | 0 | 6 | 282 |
| 03:00 PM | 7 | 114 | 0 | 0 | 121 | 0 | 1 | 6 | 0 | 7 | 0 | 111 | 0 | 0 | 111 | 4 | 0 | 2 | 0 | 6 | 245 |
| 03:15 PM | 4 | 120 | 0 | 0 | 124 | 7 | 1 | 6 | 0 | 14 | 0 | 109 | 5 | 0 | 114 | 2 | 0 | 5 | 0 | 7 | 259 |
| Total Volume | 16 | 502 | 0 | 0 | 518 | 10 | 3 | 21 | 0 | 34 | 0 | 482 | 13 | 0 | 495 | 8 | 0 | 12 | 0 | 20 | 1067 |
| % App. Total | 3.1 | 96.9 | 0 | 0 | | 29.4 | 8.8 | 61.8 | 0 | | 0 | 97.4 | 2.6 | 0 | | 40 | 0 | 60 | 0 | | |
| PHF | .571 | .930 | .000 | .000 | .932 | .357 | .750 | .875 | .000 | .607 | .000 | .873 | .650 | .000 | .878 | .500 | .000 | .600 | .000 | .714 | .946 |
| Cars | 16 | 477 | 0 | 0 | 493 | 10 | 3 | 20 | 0 | 33 | 0 | 455 | 13 | 0 | 468 | 8 | 0 | 12 | 0 | 20 | 1014 |
| % Cars | 100 | 95.0 | 0 | 0 | 95.2 | 100 | 100 | 95.2 | 0 | 97.1 | 0 | 94.4 | 100 | 0 | 94.5 | 100 | 0 | 100 | 0 | 100 | 95.0 |
| Heavy Vehicles | 0 | 25 | 0 | 0 | 25 | 0 | 0 | 1 | 0 | 1 | 0 | 27 | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 53 |
| % Heavy Vehicles | 0 | 5.0 | 0 | 0 | 4.8 | 0 | 0 | 4.8 | 0 | 2.9 | 0 | 5.6 | 0 | 0 | 5.5 | 0 | 0 | 0 | 0 | 0 | 5.0 |



N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 B
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars - Heavy Vehicles**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 0 | 2 | 0 | 0 | 36 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 20 | 0 | 0 | 61 |
| 06:45 AM | 1 | 0 | 3 | 0 | 0 | 48 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 30 | 5 | 0 | 89 |
| Total | 1 | 0 | 5 | 0 | 0 | 84 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 50 | 5 | 0 | 150 |
| 07:00 AM | 2 | 0 | 1 | 0 | 2 | 49 | 0 | 0 | 5 | 1 | 2 | 0 | 0 | 37 | 0 | 0 | 99 |
| 07:15 AM | 1 | 0 | 4 | 0 | 0 | 58 | 0 | 0 | 1 | 2 | 2 | 0 | 0 | 53 | 1 | 0 | 122 |
| 07:30 AM | 1 | 0 | 3 | 0 | 0 | 107 | 0 | 0 | 4 | 5 | 1 | 0 | 0 | 53 | 2 | 0 | 176 |
| 07:45 AM | 1 | 0 | 6 | 0 | 2 | 55 | 0 | 0 | 4 | 2 | 3 | 0 | 0 | 82 | 2 | 0 | 157 |
| Total | 5 | 0 | 14 | 0 | 4 | 269 | 0 | 0 | 14 | 10 | 8 | 0 | 0 | 225 | 5 | 0 | 554 |
| 08:00 AM | 3 | 0 | 6 | 0 | 0 | 66 | 0 | 0 | 12 | 2 | 7 | 0 | 0 | 92 | 2 | 0 | 190 |
| 08:15 AM | 1 | 0 | 1 | 0 | 2 | 75 | 0 | 0 | 16 | 7 | 6 | 0 | 0 | 57 | 0 | 0 | 165 |
| Grand Total | 10 | 0 | 26 | 0 | 6 | 494 | 0 | 1 | 43 | 20 | 23 | 0 | 0 | 424 | 12 | 0 | 1059 |
| Apprch % | 27.8 | 0 | 72.2 | 0 | 1.2 | 98.6 | 0 | 0.2 | 50 | 23.3 | 26.7 | 0 | 0 | 97.2 | 2.8 | 0 | |
| Total % | 0.9 | 0 | 2.5 | 0 | 0.6 | 46.6 | 0 | 0.1 | 4.1 | 1.9 | 2.2 | 0 | 0 | 40 | 1.1 | 0 | |
| Cars | 10 | 0 | 25 | 0 | 6 | 470 | 0 | 1 | 42 | 20 | 22 | 0 | 0 | 396 | 12 | 0 | 1004 |
| % Cars | 100 | 0 | 96.2 | 0 | 100 | 95.1 | 0 | 100 | 97.7 | 100 | 95.7 | 0 | 0 | 93.4 | 100 | 0 | 94.8 |
| Heavy Vehicles | 0 | 0 | 1 | 0 | 0 | 24 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 28 | 0 | 0 | 55 |
| % Heavy Vehicles | 0 | 0 | 3.8 | 0 | 0 | 4.9 | 0 | 0 | 2.3 | 0 | 4.3 | 0 | 0 | 6.6 | 0 | 0 | 5.2 |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 1 | 0 | 3 | 0 | 4 | 0 | 107 | 0 | 0 | 107 | 4 | 5 | 1 | 0 | 10 | 0 | 53 | 2 | 0 | 55 | 176 |
| 07:45 AM | 1 | 0 | 6 | 0 | 7 | 2 | 55 | 0 | 0 | 57 | 4 | 2 | 3 | 0 | 9 | 0 | 82 | 2 | 0 | 84 | 157 |
| 08:00 AM | 3 | 0 | 6 | 0 | 9 | 0 | 66 | 0 | 0 | 66 | 12 | 2 | 7 | 0 | 21 | 0 | 92 | 2 | 0 | 94 | 190 |
| 08:15 AM | 1 | 0 | 1 | 0 | 2 | 2 | 75 | 0 | 0 | 77 | 16 | 7 | 6 | 0 | 29 | 0 | 57 | 0 | 0 | 57 | 165 |
| Total Volume | 6 | 0 | 16 | 0 | 22 | 4 | 303 | 0 | 0 | 307 | 36 | 16 | 17 | 0 | 69 | 0 | 284 | 6 | 0 | 290 | 688 |
| % App. Total | 27.3 | 0 | 72.7 | 0 | | 1.3 | 98.7 | 0 | 0 | | 52.2 | 23.2 | 24.6 | 0 | | 0 | 97.9 | 2.1 | 0 | | |
| PHF | .500 | .000 | .667 | .000 | .611 | .500 | .708 | .000 | .000 | .717 | .563 | .571 | .607 | .000 | .595 | .000 | .772 | .750 | .000 | .771 | .905 |
| Cars | 6 | 0 | 16 | 0 | 22 | 4 | 293 | 0 | 0 | 297 | 36 | 16 | 17 | 0 | 69 | 0 | 269 | 6 | 0 | 275 | 663 |
| % Cars | 100 | 0 | 100 | 0 | 100 | 100 | 96.7 | 0 | 0 | 96.7 | 100 | 100 | 100 | 0 | 100 | 0 | 94.7 | 100 | 0 | 94.8 | 96.4 |
| Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 15 | 25 |
| % Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 3.3 | 0 | 0 | 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 5.3 | 0 | 0 | 5.2 | 3.6 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

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Email: datarequests@pdillc.com

File Name : 165320 B
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 0 | 2 | 0 | 0 | 32 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 19 | 0 | 0 | 56 |
| 06:45 AM | 1 | 0 | 3 | 0 | 0 | 43 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 28 | 5 | 0 | 82 |
| Total | 1 | 0 | 5 | 0 | 0 | 75 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 47 | 5 | 0 | 138 |
| 07:00 AM | 2 | 0 | 1 | 0 | 2 | 45 | 0 | 0 | 4 | 1 | 2 | 0 | 0 | 36 | 0 | 0 | 93 |
| 07:15 AM | 1 | 0 | 3 | 0 | 0 | 57 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 44 | 1 | 0 | 110 |
| 07:30 AM | 1 | 0 | 3 | 0 | 0 | 102 | 0 | 0 | 4 | 5 | 1 | 0 | 0 | 51 | 2 | 0 | 169 |
| 07:45 AM | 1 | 0 | 6 | 0 | 2 | 54 | 0 | 0 | 4 | 2 | 3 | 0 | 0 | 79 | 2 | 0 | 153 |
| Total | 5 | 0 | 13 | 0 | 4 | 258 | 0 | 0 | 13 | 10 | 7 | 0 | 0 | 210 | 5 | 0 | 525 |
| 08:00 AM | 3 | 0 | 6 | 0 | 0 | 63 | 0 | 0 | 12 | 2 | 7 | 0 | 0 | 89 | 2 | 0 | 184 |
| 08:15 AM | 1 | 0 | 1 | 0 | 2 | 74 | 0 | 0 | 16 | 7 | 6 | 0 | 0 | 50 | 0 | 0 | 157 |
| Grand Total | 10 | 0 | 25 | 0 | 6 | 470 | 0 | 1 | 42 | 20 | 22 | 0 | 0 | 396 | 12 | 0 | 1004 |
| Apprch % | 28.6 | 0 | 71.4 | 0 | 1.3 | 98.5 | 0 | 0.2 | 50 | 23.8 | 26.2 | 0 | 0 | 97.1 | 2.9 | 0 | |
| Total % | 1 | 0 | 2.5 | 0 | 0.6 | 46.8 | 0 | 0.1 | 4.2 | 2 | 2.2 | 0 | 0 | 39.4 | 1.2 | 0 | |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 1 | 0 | 3 | 0 | 4 | 0 | 102 | 0 | 0 | 102 | 4 | 5 | 1 | 0 | 10 | 0 | 51 | 2 | 0 | 53 | 169 |
| 07:45 AM | 1 | 0 | 6 | 0 | 7 | 2 | 54 | 0 | 0 | 56 | 4 | 2 | 3 | 0 | 9 | 0 | 79 | 2 | 0 | 81 | 153 |
| 08:00 AM | 3 | 0 | 6 | 0 | 9 | 0 | 63 | 0 | 0 | 63 | 12 | 2 | 7 | 0 | 21 | 0 | 89 | 2 | 0 | 91 | 184 |
| 08:15 AM | 1 | 0 | 1 | 0 | 2 | 2 | 74 | 0 | 0 | 76 | 16 | 7 | 6 | 0 | 29 | 0 | 50 | 0 | 0 | 50 | 157 |
| Total Volume | 6 | 0 | 16 | 0 | 22 | 4 | 293 | 0 | 0 | 297 | 36 | 16 | 17 | 0 | 69 | 0 | 269 | 6 | 0 | 275 | 663 |
| % App. Total | 27.3 | 0 | 72.7 | 0 | | 1.3 | 98.7 | 0 | 0 | | 52.2 | 23.2 | 24.6 | 0 | | 0 | 97.8 | 2.2 | 0 | | |
| PHF | .500 | .000 | .667 | .000 | .611 | .500 | .718 | .000 | .000 | .728 | .563 | .571 | .607 | .000 | .595 | .000 | .756 | .750 | .000 | .755 | .901 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
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Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 B
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Heavy Vehicles**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 06:30 AM | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 5 |
| 06:45 AM | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 7 |
| Total | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 12 |
| 07:00 AM | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 |
| 07:15 AM | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 9 | 0 | 0 | 12 |
| 07:30 AM | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 7 |
| 07:45 AM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 4 |
| Total | 0 | 0 | 1 | 0 | 0 | 11 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 15 | 0 | 0 | 29 |
| 08:00 AM | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 6 |
| 08:15 AM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 8 |
| Grand Total | 0 | 0 | 1 | 0 | 0 | 24 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 28 | 0 | 0 | 55 |
| Apprch % | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 50 | 0 | 50 | 0 | 0 | 100 | 0 | 0 | |
| Total % | 0 | 0 | 1.8 | 0 | 0 | 43.6 | 0 | 0 | 1.8 | 0 | 1.8 | 0 | 0 | 50.9 | 0 | 0 | |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 06:45 AM | | | | | | | | | | | | | | | | | | | | | |
| 06:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 7 |
| 07:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 6 |
| 07:15 AM | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 9 | 0 | 0 | 9 | 12 |
| 07:30 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 7 |
| Total Volume | 0 | 0 | 1 | 0 | 1 | 0 | 15 | 0 | 0 | 15 | 1 | 0 | 1 | 0 | 2 | 0 | 14 | 0 | 0 | 14 | 32 |
| % App. Total | 0 | 0 | 100 | 0 | | 0 | 100 | 0 | 0 | | 50 | 0 | 50 | 0 | | 0 | 100 | 0 | 0 | | |
| PHF | .000 | .000 | .250 | .000 | .250 | .000 | .750 | .000 | .000 | .750 | .250 | .000 | .250 | .000 | .500 | .000 | .389 | .000 | .000 | .389 | .667 |

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**Groups Printed- Peds and Bikes**

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | Right | Thru | Left | Peds SB | Peds NB | Right | Thru | Left | Peds WB | Peds EB | Right | Thru | Left | Peds NB | Peds SB | Int. Total |
| 06:30 AM | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 06:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 6 |
| Total | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 3 | 0 | 0 | 0 | 12 |
| 07:00 AM | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 7 |
| 07:15 AM | 0 | 0 | 0 | 4 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 2 | 0 | 1 | 0 | 18 |
| 07:30 AM | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 1 | 2 | 13 |
| 07:45 AM | 0 | 0 | 0 | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 3 | 0 | 0 | 3 | 24 |
| Total | 0 | 0 | 0 | 4 | 5 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 11 | 0 | 9 | 0 | 2 | 5 | 62 |
| 08:00 AM | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 9 |
| 08:15 AM | 0 | 0 | 0 | 1 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 13 | 1 | 0 | 2 | 0 | 2 | 0 | 26 |
| Grand Total | 0 | 0 | 0 | 5 | 18 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 1 | 28 | 13 | 0 | 14 | 0 | 5 | 7 | 109 |
| Apprch % | 0 | 0 | 0 | 21.7 | 78.3 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 2.4 | 66.7 | 31 | 0 | 53.8 | 0 | 19.2 | 26.9 | |
| Total % | 0 | 0 | 0 | 4.6 | 16.5 | 0 | 16.5 | 0 | 0 | 0 | 0 | 0 | 0.9 | 25.7 | 11.9 | 0 | 12.8 | 0 | 4.6 | 6.4 | |

| | Tufts Street From North | | | | | | Broadway From East | | | | | | Tufts Street From South | | | | | | Broadway From West | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | App. Total | Right | Thru | Left | Peds SB | Peds NB | App. Total | Right | Thru | Left | Peds WB | Peds EB | App. Total | Right | Thru | Left | Peds NB | Peds SB | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 1 | 2 | 6 | 13 |
| 07:45 AM | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 6 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 11 | 11 | 0 | 3 | 0 | 0 | 3 | 6 | 24 |
| 08:00 AM | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 2 | 3 | 9 |
| 08:15 AM | 0 | 0 | 0 | 1 | 5 | 6 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 13 | 1 | 15 | 0 | 2 | 0 | 2 | 0 | 4 | 26 |
| Total Volume | 0 | 0 | 0 | 1 | 10 | 11 | 0 | 11 | 0 | 0 | 0 | 11 | 0 | 0 | 1 | 17 | 13 | 31 | 0 | 8 | 0 | 4 | 7 | 19 | 72 |
| % App. Total | 0 | 0 | 0 | 9.1 | 90.9 | | 0 | 100 | 0 | 0 | 0 | | 0 | 0 | 3.2 | 54.8 | 41.9 | | 0 | 42.1 | 0 | 21.1 | 36.8 | | |
| PHF | .000 | .000 | .000 | .250 | .500 | .458 | .000 | .458 | .000 | .000 | .000 | .458 | .000 | .000 | .250 | .327 | .295 | .517 | .000 | .667 | .000 | .500 | .583 | .792 | .692 |

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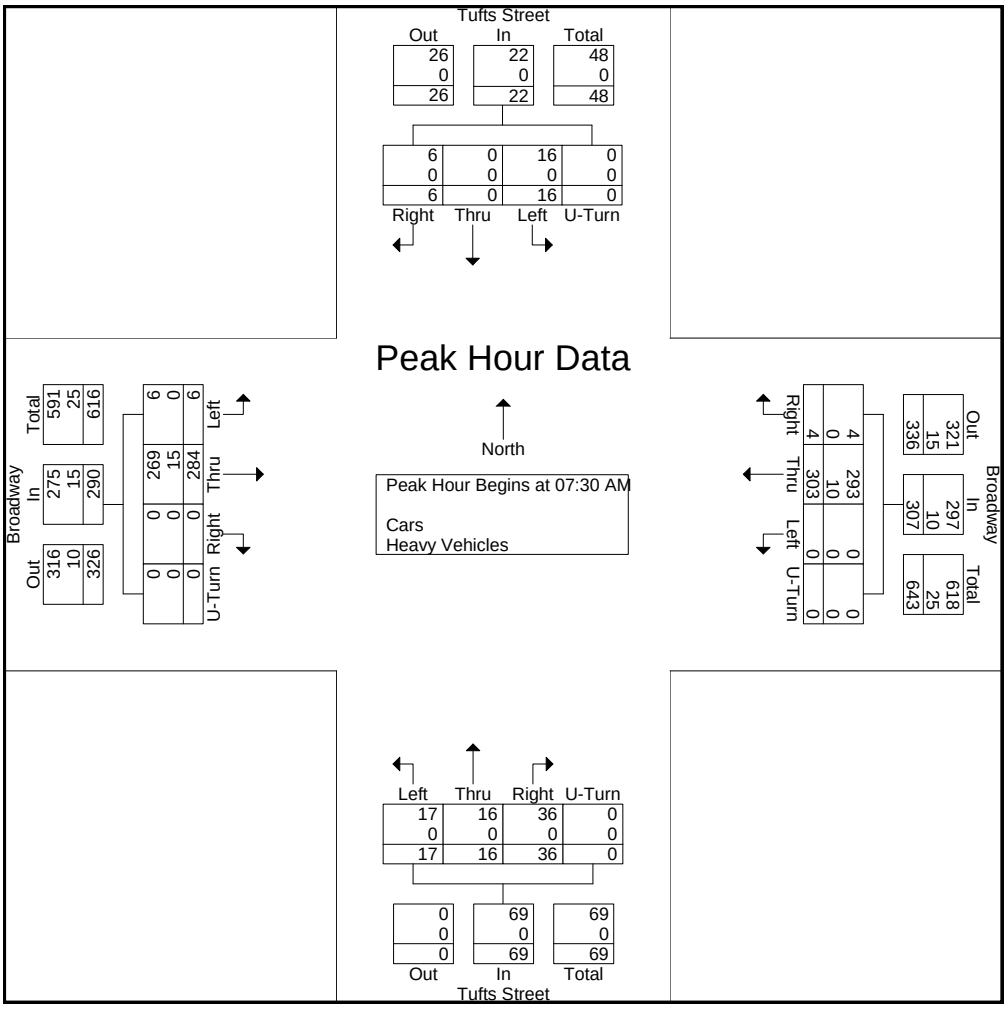
| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:30 AM | | | | | | | | | | | | | | | | | | | | | |
| 07:30 AM | 1 | 0 | 3 | 0 | 4 | 0 | 107 | 0 | 0 | 107 | 4 | 5 | 1 | 0 | 10 | 0 | 53 | 2 | 0 | 55 | 176 |
| 07:45 AM | 1 | 0 | 6 | 0 | 7 | 2 | 55 | 0 | 0 | 57 | 4 | 2 | 3 | 0 | 9 | 0 | 82 | 2 | 0 | 84 | 157 |
| 08:00 AM | 3 | 0 | 6 | 0 | 9 | 0 | 66 | 0 | 0 | 66 | 12 | 2 | 7 | 0 | 21 | 0 | 92 | 2 | 0 | 94 | 190 |
| 08:15 AM | 1 | 0 | 1 | 0 | 2 | 2 | 75 | 0 | 0 | 77 | 16 | 7 | 6 | 0 | 29 | 0 | 57 | 0 | 0 | 57 | 165 |
| Total Volume | 6 | 0 | 16 | 0 | 22 | 4 | 303 | 0 | 0 | 307 | 36 | 16 | 17 | 0 | 69 | 0 | 284 | 6 | 0 | 290 | 688 |
| % App. Total | 27.3 | 0 | 72.7 | 0 | | 1.3 | 98.7 | 0 | 0 | | 52.2 | 23.2 | 24.6 | 0 | | 0 | 97.9 | 2.1 | 0 | | |
| PHF | .500 | .000 | .667 | .000 | .611 | .500 | .708 | .000 | .000 | .717 | .563 | .571 | .607 | .000 | .595 | .000 | .772 | .750 | .000 | .771 | .905 |
| Cars | 6 | 0 | 16 | 0 | 22 | 4 | 293 | 0 | 0 | 297 | 36 | 16 | 17 | 0 | 69 | 0 | 269 | 6 | 0 | 275 | 663 |
| % Cars | 100 | 0 | 100 | 0 | 100 | 100 | 96.7 | 0 | 0 | 96.7 | 100 | 100 | 100 | 0 | 100 | 0 | 94.7 | 100 | 0 | 94.8 | 96.4 |
| Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 15 | 25 |
| % Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 3.3 | 0 | 0 | 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 5.3 | 0 | 0 | 5.2 | 3.6 |



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Page No : 1

**Groups Printed- Cars - Heavy Vehicles**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 1 | 0 | 2 | 0 | 0 | 37 | 0 | 1 | 4 | 5 | 5 | 0 | 0 | 27 | 2 | 0 | 84 |
| 02:15 PM | 0 | 0 | 2 | 0 | 0 | 44 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 39 | 1 | 0 | 91 |
| 02:30 PM | 1 | 0 | 1 | 0 | 0 | 56 | 0 | 0 | 6 | 2 | 2 | 0 | 0 | 26 | 2 | 0 | 96 |
| 02:45 PM | 2 | 0 | 1 | 0 | 0 | 64 | 0 | 0 | 4 | 5 | 9 | 0 | 0 | 37 | 3 | 0 | 125 |
| Total | 4 | 0 | 6 | 0 | 0 | 201 | 0 | 1 | 16 | 15 | 16 | 0 | 0 | 129 | 8 | 0 | 396 |
| 03:00 PM | 2 | 0 | 4 | 0 | 0 | 47 | 0 | 0 | 7 | 1 | 4 | 0 | 0 | 38 | 2 | 0 | 105 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 9 | 4 | 5 | 0 | 0 | 44 | 0 | 0 | 102 |
| 03:30 PM | 4 | 0 | 3 | 0 | 0 | 54 | 0 | 0 | 6 | 4 | 7 | 0 | 0 | 37 | 3 | 0 | 118 |
| 03:45 PM | 4 | 0 | 2 | 0 | 0 | 61 | 0 | 0 | 7 | 3 | 4 | 0 | 0 | 51 | 4 | 2 | 138 |
| Total | 10 | 0 | 9 | 0 | 0 | 202 | 0 | 0 | 29 | 12 | 20 | 0 | 0 | 170 | 9 | 2 | 463 |
| Grand Total | 14 | 0 | 15 | 0 | 0 | 403 | 0 | 1 | 45 | 27 | 36 | 0 | 0 | 299 | 17 | 2 | 859 |
| Apprch % | 48.3 | 0 | 51.7 | 0 | 0 | 99.8 | 0 | 0.2 | 41.7 | 25 | 33.3 | 0 | 0 | 94 | 5.3 | 0.6 | |
| Total % | 1.6 | 0 | 1.7 | 0 | 0 | 46.9 | 0 | 0.1 | 5.2 | 3.1 | 4.2 | 0 | 0 | 34.8 | 2 | 0.2 | |
| Cars | 14 | 0 | 15 | 0 | 0 | 371 | 0 | 1 | 42 | 25 | 36 | 0 | 0 | 287 | 16 | 2 | 809 |
| % Cars | 100 | 0 | 100 | 0 | 0 | 92.1 | 0 | 100 | 93.3 | 92.6 | 100 | 0 | 0 | 96 | 94.1 | 100 | 94.2 |
| Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 12 | 1 | 0 | 50 |
| % Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 7.9 | 0 | 0 | 6.7 | 7.4 | 0 | 0 | 0 | 4 | 5.9 | 0 | 5.8 |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 03:00 PM | | | | | | | | | | | | | | | | | | | | | |
| 03:00 PM | 2 | 0 | 4 | 0 | 6 | 0 | 47 | 0 | 0 | 47 | 7 | 1 | 4 | 0 | 12 | 0 | 38 | 2 | 0 | 40 | 105 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 40 | 9 | 4 | 5 | 0 | 18 | 0 | 44 | 0 | 0 | 44 | 102 |
| 03:30 PM | 4 | 0 | 3 | 0 | 7 | 0 | 54 | 0 | 0 | 54 | 6 | 4 | 7 | 0 | 17 | 0 | 37 | 3 | 0 | 40 | 118 |
| 03:45 PM | 4 | 0 | 2 | 0 | 6 | 0 | 61 | 0 | 0 | 61 | 7 | 3 | 4 | 0 | 14 | 0 | 51 | 4 | 2 | 57 | 138 |
| Total Volume | 10 | 0 | 9 | 0 | 19 | 0 | 202 | 0 | 0 | 202 | 29 | 12 | 20 | 0 | 61 | 0 | 170 | 9 | 2 | 181 | 463 |
| % App. Total | 52.6 | 0 | 47.4 | 0 | | 0 | 100 | 0 | 0 | | 47.5 | 19.7 | 32.8 | 0 | | 0 | 93.9 | 5 | 1.1 | | |
| PHF | .625 | .000 | .563 | .000 | .679 | .000 | .828 | .000 | .000 | .828 | .806 | .750 | .714 | .000 | .847 | .000 | .833 | .563 | .250 | .794 | .839 |
| Cars | 10 | 0 | 9 | 0 | 19 | 0 | 191 | 0 | 0 | 191 | 27 | 11 | 20 | 0 | 58 | 0 | 164 | 8 | 2 | 174 | 442 |
| % Cars | 100 | 0 | 100 | 0 | 100 | 0 | 94.6 | 0 | 0 | 94.6 | 93.1 | 91.7 | 100 | 0 | 95.1 | 0 | 96.5 | 88.9 | 100 | 96.1 | 95.5 |
| Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 11 | 2 | 1 | 0 | 0 | 3 | 0 | 6 | 1 | 0 | 7 | 21 |
| % Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 5.4 | 0 | 0 | 5.4 | 6.9 | 8.3 | 0 | 0 | 4.9 | 0 | 3.5 | 11.1 | 0 | 3.9 | 4.5 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 BB
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Cars**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 1 | 0 | 2 | 0 | 0 | 30 | 0 | 1 | 4 | 5 | 5 | 0 | 0 | 27 | 2 | 0 | 77 |
| 02:15 PM | 0 | 0 | 2 | 0 | 0 | 42 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 38 | 1 | 0 | 87 |
| 02:30 PM | 1 | 0 | 1 | 0 | 0 | 48 | 0 | 0 | 6 | 2 | 2 | 0 | 0 | 23 | 2 | 0 | 85 |
| 02:45 PM | 2 | 0 | 1 | 0 | 0 | 60 | 0 | 0 | 4 | 4 | 9 | 0 | 0 | 35 | 3 | 0 | 118 |
| Total | 4 | 0 | 6 | 0 | 0 | 180 | 0 | 1 | 15 | 14 | 16 | 0 | 0 | 123 | 8 | 0 | 367 |
| 03:00 PM | 2 | 0 | 4 | 0 | 0 | 43 | 0 | 0 | 7 | 1 | 4 | 0 | 0 | 35 | 2 | 0 | 98 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 8 | 3 | 5 | 0 | 0 | 43 | 0 | 0 | 98 |
| 03:30 PM | 4 | 0 | 3 | 0 | 0 | 50 | 0 | 0 | 5 | 4 | 7 | 0 | 0 | 37 | 2 | 0 | 112 |
| 03:45 PM | 4 | 0 | 2 | 0 | 0 | 59 | 0 | 0 | 7 | 3 | 4 | 0 | 0 | 49 | 4 | 2 | 134 |
| Total | 10 | 0 | 9 | 0 | 0 | 191 | 0 | 0 | 27 | 11 | 20 | 0 | 0 | 164 | 8 | 2 | 442 |
| Grand Total | 14 | 0 | 15 | 0 | 0 | 371 | 0 | 1 | 42 | 25 | 36 | 0 | 0 | 287 | 16 | 2 | 809 |
| Apprch % | 48.3 | 0 | 51.7 | 0 | 0 | 99.7 | 0 | 0.3 | 40.8 | 24.3 | 35 | 0 | 0 | 94.1 | 5.2 | 0.7 | |
| Total % | 1.7 | 0 | 1.9 | 0 | 0 | 45.9 | 0 | 0.1 | 5.2 | 3.1 | 4.4 | 0 | 0 | 35.5 | 2 | 0.2 | |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 03:00 PM | | | | | | | | | | | | | | | | | | | | | |
| 03:00 PM | 2 | 0 | 4 | 0 | 6 | 0 | 43 | 0 | 0 | 43 | 7 | 1 | 4 | 0 | 12 | 0 | 35 | 2 | 0 | 37 | 98 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 39 | 8 | 3 | 5 | 0 | 16 | 0 | 43 | 0 | 0 | 43 | 98 |
| 03:30 PM | 4 | 0 | 3 | 0 | 7 | 0 | 50 | 0 | 0 | 50 | 5 | 4 | 7 | 0 | 16 | 0 | 37 | 2 | 0 | 39 | 112 |
| 03:45 PM | 4 | 0 | 2 | 0 | 6 | 0 | 59 | 0 | 0 | 59 | 7 | 3 | 4 | 0 | 14 | 0 | 49 | 4 | 2 | 55 | 134 |
| Total Volume | 10 | 0 | 9 | 0 | 19 | 0 | 191 | 0 | 0 | 191 | 27 | 11 | 20 | 0 | 58 | 0 | 164 | 8 | 2 | 174 | 442 |
| % App. Total | 52.6 | 0 | 47.4 | 0 | | 0 | 100 | 0 | 0 | | 46.6 | 19 | 34.5 | 0 | | 0 | 94.3 | 4.6 | 1.1 | | |
| PHF | .625 | .000 | .563 | .000 | .679 | .000 | .809 | .000 | .000 | .809 | .844 | .688 | .714 | .000 | .906 | .000 | .837 | .500 | .250 | .791 | .825 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 BB
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Heavy Vehicles**

| | Tufts Street From North | | | | Broadway From East | | | | Tufts Street From South | | | | Broadway From West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Right | Thru | Left | U-Turn | Int. Total |
| 02:00 PM | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 02:15 PM | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| 02:30 PM | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 11 |
| 02:45 PM | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 7 |
| Total | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 29 |
| 03:00 PM | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 7 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| 03:30 PM | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 |
| 03:45 PM | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 |
| Total | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 6 | 1 | 0 | 21 |
| Grand Total | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 12 | 1 | 0 | 50 |
| Apprch % | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 60 | 40 | 0 | 0 | 0 | 92.3 | 7.7 | 0 | |
| Total % | 0 | 0 | 0 | 0 | 0 | 64 | 0 | 0 | 6 | 4 | 0 | 0 | 0 | 24 | 2 | 0 | |

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:00 PM | | | | | | | | | | | | | | | | | | | | | |
| 02:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 02:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 4 |
| 02:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 11 |
| 02:45 PM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 2 | 7 |
| Total Volume | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 21 | 1 | 1 | 0 | 0 | 2 | 0 | 6 | 0 | 0 | 6 | 29 |
| % App. Total | 0 | 0 | 0 | 0 | | 0 | 100 | 0 | 0 | | 50 | 50 | 0 | 0 | | 0 | 100 | 0 | 0 | | |
| PHF | .000 | .000 | .000 | .000 | .000 | .000 | .656 | .000 | .000 | .656 | .250 | .250 | .000 | .000 | .500 | .000 | .500 | .000 | .000 | .500 | .659 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

File Name : 165320 BB
Site Code : 13682.00
Start Date : 10/13/2016
Page No : 1

**Groups Printed- Peds and Bikes**

| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | Right | Thru | Left | Peds SB | Peds NB | Right | Thru | Left | Peds WB | Peds EB | Right | Thru | Left | Peds NB | Peds SB | Int. Total |
| 02:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 5 | 0 | 2 | 0 | 1 | 2 | 13 |
| 02:15 PM | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 7 |
| 02:30 PM | 0 | 0 | 0 | 5 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 14 |
| 02:45 PM | 0 | 0 | 0 | 7 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 9 | 2 | 0 | 1 | 0 | 2 | 5 | 30 |
| Total | 0 | 0 | 0 | 13 | 6 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 13 | 8 | 0 | 4 | 0 | 5 | 9 | 64 |
| 03:00 PM | 0 | 0 | 0 | 7 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 0 | 1 | 0 | 2 | 0 | 21 |
| 03:15 PM | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 3 | 13 |
| 03:30 PM | 0 | 0 | 0 | 5 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 18 |
| 03:45 PM | 0 | 0 | 0 | 6 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | 1 | 0 | 2 | 0 | 0 | 3 | 29 |
| Total | 0 | 0 | 0 | 20 | 18 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 19 | 6 | 0 | 5 | 0 | 2 | 6 | 81 |
| Grand Total | 0 | 0 | 0 | 33 | 24 | 0 | 7 | 0 | 1 | 1 | 1 | 1 | 0 | 32 | 14 | 0 | 9 | 0 | 7 | 15 | 145 |
| Apprch % | 0 | 0 | 0 | 57.9 | 42.1 | 0 | 77.8 | 0 | 11.1 | 11.1 | 2.1 | 2.1 | 0 | 66.7 | 29.2 | 0 | 29 | 0 | 22.6 | 48.4 | |
| Total % | 0 | 0 | 0 | 22.8 | 16.6 | 0 | 4.8 | 0 | 0.7 | 0.7 | 0.7 | 0.7 | 0 | 22.1 | 9.7 | 0 | 6.2 | 0 | 4.8 | 10.3 | |

| | Tufts Street From North | | | | | | Broadway From East | | | | | | Tufts Street From South | | | | | | Broadway From West | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds EB | Peds WB | App. Total | Right | Thru | Left | Peds SB | Peds NB | App. Total | Right | Thru | Left | Peds WB | Peds EB | App. Total | Right | Thru | Left | Peds NB | Peds SB | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:45 PM | | | | | | | | | | | | | | | | | | | | | | | | | |
| 02:45 PM | 0 | 0 | 0 | 7 | 2 | 9 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 9 | 2 | 11 | 0 | 1 | 0 | 2 | 5 | 8 | 30 |
| 03:00 PM | 0 | 0 | 0 | 7 | 4 | 11 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 2 | 6 | 0 | 1 | 0 | 2 | 0 | 3 | 21 |
| 03:15 PM | 0 | 0 | 0 | 2 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 5 | 0 | 0 | 0 | 0 | 3 | 3 | 13 |
| 03:30 PM | 0 | 0 | 0 | 5 | 3 | 8 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 4 | 2 | 7 | 0 | 2 | 0 | 0 | 0 | 2 | 18 |
| Total Volume | 0 | 0 | 0 | 21 | 12 | 33 | 0 | 3 | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 21 | 7 | 29 | 0 | 4 | 0 | 4 | 8 | 16 | 82 |
| % App. Total | 0 | 0 | 0 | 63.6 | 36.4 | | 0 | 75 | 0 | 25 | 0 | | 3.4 | 0 | 0 | 72.4 | 24.1 | | 0 | 25 | 0 | 25 | 50 | | |
| PHF | .000 | .000 | .000 | .750 | .750 | .750 | .000 | .750 | .000 | .250 | .000 | .500 | .250 | .000 | .000 | .583 | .875 | .659 | .000 | .500 | .000 | .500 | .400 | .500 | .683 |

N/S: Tufts Street
E/W: Broadway
City, State: Arlington, MA
Client: VHB/ C. Trearchis

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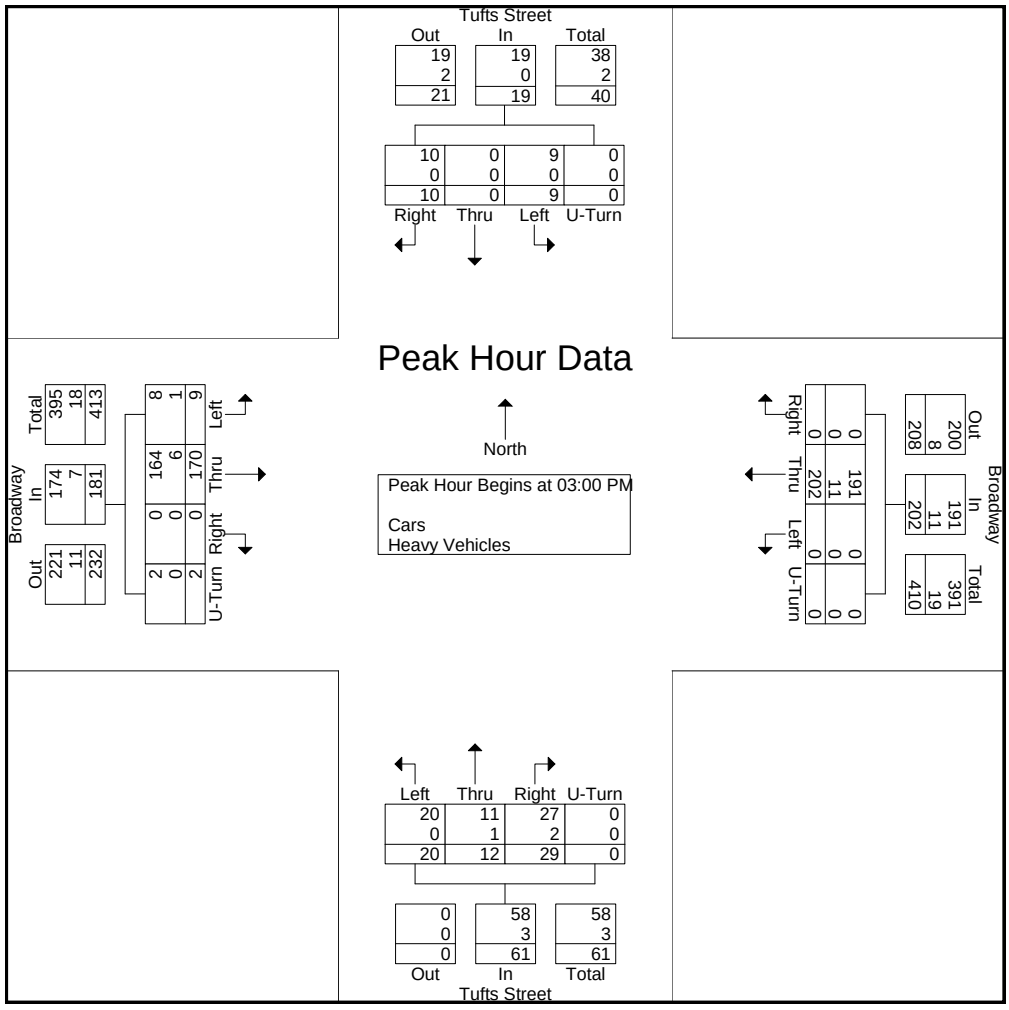
| | Tufts Street From North | | | | | Broadway From East | | | | | Tufts Street From South | | | | | Broadway From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Right | Thru | Left | U-Turn | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 03:00 PM | | | | | | | | | | | | | | | | | | | | | |
| 03:00 PM | 2 | 0 | 4 | 0 | 6 | 0 | 47 | 0 | 0 | 47 | 7 | 1 | 4 | 0 | 12 | 0 | 38 | 2 | 0 | 40 | 105 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 40 | 9 | 4 | 5 | 0 | 18 | 0 | 44 | 0 | 0 | 44 | 102 |
| 03:30 PM | 4 | 0 | 3 | 0 | 7 | 0 | 54 | 0 | 0 | 54 | 6 | 4 | 7 | 0 | 17 | 0 | 37 | 3 | 0 | 40 | 118 |
| 03:45 PM | 4 | 0 | 2 | 0 | 6 | 0 | 61 | 0 | 0 | 61 | 7 | 3 | 4 | 0 | 14 | 0 | 51 | 4 | 2 | 57 | 138 |
| Total Volume | 10 | 0 | 9 | 0 | 19 | 0 | 202 | 0 | 0 | 202 | 29 | 12 | 20 | 0 | 61 | 0 | 170 | 9 | 2 | 181 | 463 |
| % App. Total | 52.6 | 0 | 47.4 | 0 | | 0 | 100 | 0 | 0 | | 47.5 | 19.7 | 32.8 | 0 | | 0 | 93.9 | 5 | 1.1 | | |
| PHF | .625 | .000 | .563 | .000 | .679 | .000 | .828 | .000 | .000 | .828 | .806 | .750 | .714 | .000 | .847 | .000 | .833 | .563 | .250 | .794 | .839 |
| Cars | 10 | 0 | 9 | 0 | 19 | 0 | 191 | 0 | 0 | 191 | 27 | 11 | 20 | 0 | 58 | 0 | 164 | 8 | 2 | 174 | 442 |
| % Cars | 100 | 0 | 100 | 0 | 100 | 0 | 94.6 | 0 | 0 | 94.6 | 93.1 | 91.7 | 100 | 0 | 95.1 | 0 | 96.5 | 88.9 | 100 | 96.1 | 95.5 |
| Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 11 | 2 | 1 | 0 | 0 | 3 | 0 | 6 | 1 | 0 | 7 | 21 |
| % Heavy Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 5.4 | 0 | 0 | 5.4 | 6.9 | 8.3 | 0 | 0 | 4.9 | 0 | 3.5 | 11.1 | 0 | 3.9 | 4.5 |



# Seasonal Adjustment Factors

***MASSACHUSETTS HIGHWAY DEPARTMENT - STATEWIDE TRAFFIC DATA COLLECTION***

## 2011 WEEKDAY SEASONAL FACTORS *

* Note: These are weekday factors. The average of the factors for the year will not equal 1, as weekend data are not considered.

| FACTOR GROUP | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROUP 1 - WEST INTERSTATE | 0.98 | 0.93 | 0.90 | 0.89 | 0.90 | 0.88 | 0.91 | 0.90 | 0.89 | 0.89 | 0.93 | 0.95 |
| Use group 2 for R5, R6, & R0<br>GROUP 2 - RURAL MAJOR COLLECTOR (R-5) | 1.12 | 1.12 | 1.07 | 0.99 | 0.91 | 0.90 | 0.86 | 0.86 | 0.92 | 0.93 | 1.01 | 1.05 |
| GROUP 3A - RECREATIONAL **(1-4) See below | 1.26 | 1.25 | 1.20 | 1.06 | 0.96 | 0.89 | 0.76 | 0.76 | 0.92 | 0.99 | 1.08 | 1.14 |
| GROUP 3B - RECREATIONAL ***(5) See below | 1.22 | 1.26 | 1.22 | 1.06 | 0.96 | 0.90 | 0.72 | 0.74 | 0.97 | 1.02 | 1.14 | 1.15 |
| GROUP 4 - I-495 INTERSTATE | 1.02 | 1.00 | 1.00 | 0.96 | 0.92 | 0.89 | 0.85 | 0.83 | 0.93 | 0.96 | 1.01 | 1.03 |
| GROUP 5 - EAST INTERSTATE | 1.04 | 1.00 | 0.96 | 0.93 | 0.92 | 0.91 | 0.91 | 0.89 | 0.93 | 0.93 | 0.96 | 1.01 |
| Use group 6 for U2, U3, U5, U6, U0, R2, & R3<br>GROUP 6 - URBAN ARTERIALS, COLLECTORS & RURAL ARTERIALS (R-2, R-3) | 1.03 | 1.01 | 0.96 | 0.92 | 0.91 | 0.90 | 0.92 | 0.92 | 0.93 | 0.92 | 0.97 | 0.97 |
| GROUP 7 - I-84 PROXIMITY (STAS. 17,3921) | 1.24 | 1.24 | 1.15 | 1.04 | 0.99 | 1.00 | 0.93 | 0.89 | 1.05 | 1.05 | 1.05 | 1.12 |
| GROUP 8 - I-295 PROXIMITY (STA. 6590) | 1.00 | 0.99 | 0.95 | 0.92 | 0.94 | 0.91 | 0.93 | 0.92 | 0.95 | 0.94 | 0.97 | 0.95 |
| GROUP 9 - I-195 PROXIMITY (STA. 7) | 1.13 | 1.05 | 1.03 | 0.95 | 0.89 | 0.87 | 0.86 | 0.79 | 0.88 | 0.91 | 0.99 | 1.03 |

***RECREATIONAL: (ALL YEARS)***

****GROUP 3A:**

1. CAPE COD (ALL TOWNS)
2. PLYMOUTH(SOUTH OF RTE.3A)

7014, 7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108,7178

3. MARTHA'S VINEYARD
4. NANTUCKET

*****GROUP 3B:**

5. PERMANENTS 2 & 189

1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,
1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,
1105,1106,1107,1108,1113,1114,1116,2196,2197,2198

## 2011 AXLE CORRECTION FACTORS

| ROAD INVENTORY FUNCTIONAL CLASSIFICATION | AXLE CORRECTION FACTOR |
|---|---|
| RURAL | |
| 1 | 0.95 |
| 2 | 0.97 |
| 3 | 0.98 |
| 0,5,6 | 0.98 |
| URBAN | |
| 1 | 0.96 |
| 2 | 0.98 |
| 3 | 0.98 |
| 5 | 0.98 |
| 0,6 | 0.99 |
| I-84 | 0.90 |

Apply I-84 factor to stations: 3290,3929

## ROUND OFF

0 - 999.....10
> 1,000.....100

# Background Growth

| Route 2 | | | |
|---|---|---|---|
| Year | Volume | Growth | # of Years |
| 2011 | 63,648 | -1.88% | 9 years |
| 2010 | 49,500 | | |
| 2008 | 48,953 | | |
| 2007 | 50,893 | | |
| 2006 | 51,874 | | |
| 2005 | 51,700 | | |
| 2004 | 76,209 | | |
| 2003 | 75,250 | | |
| 2002 | 75,500 | | |

| Mass Ave | | |
|---|---|---|
| Year | Volume | Growth |
| 2010 | 20,000 | 0.19% |
| 2002 | 19,700 | |

| Broadway | | |
|---|---|---|
| Year | Volume | Growth |
| 2010 | 10,643 | -0.75% |
| 2002 | 11,300 | |

List View | All DIRs

Record 1 of 1 Goto Record go

| | | | |
|---|---|---|---|
| Location ID | 4936 | MPO ID | |
| Type | SPOT | HPMS ID | |
| On NHS | | On HPMS | No |
| LRS ID | | LRS Loc Pt. | |
| SF Group | U3 | Route Type | |
| AF Group | U3 | Route | |
| GF Group | U3 | | |
| Class Dist Grp | | | |
| WIM Group | | | |
| QC Group | Default | | |
| Fnct'l Class | (3) Other Principal Arterial | Milepost | |
| Located On | BROADWAY | | |
| Loc On Alias | | | |
| SOUTH OF | HARLOW STREET | | |

| PR | MP | PT |
|---|---|---|
| | | |

More Detail

## STATION DATA

Directions: 2-WAY

### AADT

| | Year | AADT | DHV-30 | K % | D % | PA | BC | Src |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 10,643 | | | | | | |
| | 2002 | 11,300 | | | | | | |

### Travel Demand Model

| | Model Year | Model AADT | AM PHV | AM PPV | MD PHV | MD PPV | PM PHV | PM PPV | NT PHV | NT PPV |
|---|---|---|---|---|---|---|---|---|---|---|

### VOLUME COUNT

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### VOLUME TREND

| Year | Annual Growth |
|---|---|
| 2010 | -1% |

### SPEED

| | Date | Int | Pace | 85th | Total |
|---|---|---|---|---|---|
| No Data | | | | | |

### CLASSIFICATION

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### WEIGH-IN-MOTION

| | Date | Axles | Avg GVW | Total |
|---|---|---|---|---|
| No Data | | | | |

### PER VEHICLE

| | Date | Axles | 85th | Total |
|---|---|---|---|---|
| No Data | | | | |

### GAP

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### PARTIAL COUNT

| | Date | Int | 24-Hr Total |
|---|---|---|---|

### NOTES/FILES

| | Note | Date | |
|---|---|---|---|

List View | All DIRs

Record 1 of 1 Goto Record go

| | | | |
|---|---|---|---|
| Location ID | 4935 | MPO ID | |
| Type | SPOT | HPMS ID | |
| On NHS | | On HPMS | No |
| LRS ID | | LRS Loc Pt. | |
| SF Group | U3 | Route Type | |
| AF Group | U3 | Route | |
| GF Group | U3 | | |
| Class Dist Grp | | | |
| WIM Group | | | |
| QC Group | Default | | |
| Fnct'l Class | (3) Other Principal Arterial | Milepost | |
| Located On | MASSACHUSETTS AVENUE | | |
| Loc On Alias | | | |
| SOUTH OF | AVON PL | | |

| PR | MP | PT |
|---|---|---|
| | | |

More Detail

## STATION DATA

Directions: 2-WAY

### AADT

| | Year | AADT | DHV-30 | K % | D % | PA | BC | Src |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 20,000 | | | | | | |
| | 2002 | 19,700 | | | | | | |

### Travel Demand Model

| | Model Year | Model AADT | AM PHV | AM PPV | MD PHV | MD PPV | PM PHV | PM PPV | NT PHV | NT PPV |
|---|---|---|---|---|---|---|---|---|---|---|

### VOLUME COUNT

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### VOLUME TREND

| Year | Annual Growth |
|---|---|
| 2010 | 0% |

### SPEED

| | Date | Int | Pace | 85th | Total |
|---|---|---|---|---|---|
| No Data | | | | | |

### CLASSIFICATION

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### WEIGH-IN-MOTION

| | Date | Axles | Avg GVW | Total |
|---|---|---|---|---|
| No Data | | | | |

### PER VEHICLE

| | Date | Axles | 85th | Total |
|---|---|---|---|---|
| No Data | | | | |

### GAP

| | Date | Int | Total |
|---|---|---|---|
| No Data | | | |

### PARTIAL COUNT

| | Date | Int | 24-Hr Total |
|---|---|---|---|

### NOTES/FILES

| | Note | Date | |
|---|---|---|---|

Transportation Data Management System

List View | All DIRs

Record 1 of 1 Goto Record go

| | | | |
|---|---|---|---|
| Location ID | 822 | MPO ID | |
| Type | SPOT | HPMS ID | 010060900100 |
| On NHS | | On HPMS | Yes |
| LRS ID | | LRS Loc Pt. | |
| SF Group | U2 | Route Type | |
| AF Group | U2 | Route | |
| GF Group | U2 | | |
| Class Dist Grp | | | |
| WIM Group | | | |
| QC Group | Perm | | |
| Fnct'l Class | (2) Freeway & Expressway | Milepost | |
| Located On | CONCORD TURNPIKE | | |
| Loc On Alias | | | |
| AT | BELMONT TOWN LINE | | |

| PR | MP | PT |
|---|---|---|
| | | |

More Detail

## STATION DATA

Directions: 2-WAY | EB 1 | WB 1

### AADT

| | Year | AADT | DHV-30 | K % | D % | PA | BC | Src |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 49,500 | | | | | | |
| | 2008 | 48,953 | | | | | | E |
| | 2007 | 50,893 | | | | | | E |
| | 2006 | 51,874 | | | | | | E |
| | 2005 | 51,700 | | | | | | |

|<< < > >>| 1-5 of 16

### Travel Demand Model

| | Model Year | Model AADT | AM PHV | AM PPV | MD PHV | MD PPV | PM PHV | PM PPV | NT PHV | NT PPV |
|---|---|---|---|---|---|---|---|---|---|---|

### VOLUME COUNT

| | Date | Int | Total |
|---|---|---|---|
| | Wed 8/24/2011 | 15 | 65,237 |
| | Tue 8/23/2011 | 15 | 63,648 |
| | Mon 8/22/2011 | 15 | 61,592 |
| | Tue 10/20/1987 | 60 | 67,357 |
| | Mon 10/19/1987 | 60 | 66,319 |
| | Sun 10/18/1987 | 60 | 51,608 |
| | Sat 10/17/1987 | 60 | 59,139 |
| | Fri 10/16/1987 | 60 | 71,563 |
| | Thu 10/15/1987 | 60 | 69,313 |
| | Wed 10/14/1987 | 60 | 69,636 |

### VOLUME TREND

| Year | Annual Growth |
|---|---|
| 2011 | 28% |
| 2010 | 1% |
| 2008 | -4% |
| 2007 | -2% |
| 2006 | 0% |
| 2005 | -32% |
| 2004 | 1% |
| 2003 | 0% |
| 2002 | 0% |
| 1992 | 7% |

# Trip Generation

| Project Information | |
|---|---|
| **Project Name:** | Gibbs School |
| **No:** | 13682 |
| **Date:** | 10/26/2016 |
| **City:** | |
| **State/Province:** | |
| **Zip/Postal Code:** | |
| **Country:** | |
| **Client Name:** | |
| **Analyst's Name:** | |
| **Edition:** | ITE-TGM 9th Edition |

| Land Use | Size | Weekday Morning | | Weekday Afternoon | |
|---|---|---|---|---|---|
| | | Entry | Exit | Entry | Exit |
| **522 - Middle School/Junior High School** | 500 Students | 149 | 121 | 68 | 82 |
| Reduction | | 0 | 0 | 0 | 0 |
| Internal | | 0 | 0 | 0 | 0 |
| Pass-by | | 0 | 0 | 0 | 0 |
| Non-pass-by | | 149 | 121 | 68 | 82 |
| **534 - Private School (K-8)** | 174 Students | 88 | 72 | 47 | 54 |
| Reduction | | 0 | 0 | 0 | 0 |
| Internal | | 0 | 0 | 0 | 0 |
| Pass-by | | 0 | 0 | 0 | 0 |
| Non-pass-by | | 88 | 72 | 47 | 54 |
| **565 - Day Care Center** | 75 Students | 31 | 27 | 28 | 32 |
| Reduction | | 0 | 0 | 0 | 0 |
| Internal | | 0 | 0 | 0 | 0 |
| Pass-by | | 0 | 0 | 0 | 0 |
| Non-pass-by | | 31 | 27 | 28 | 32 |
| **534 - Private School (K-8) - 1** | 239 Students | 120 | 98 | 66 | 75 |
| Reduction | | 0 | 0 | 0 | 0 |
| Internal | | 0 | 0 | 0 | 0 |
| Pass-by | | 0 | 0 | 0 | 0 |
| Non-pass-by | | 120 | 98 | 66 | 75 |
| **Total** | | 388 | 318 | 209 | 243 |
| **Total Reduction** | | 0 | 0 | 0 | 0 |
| **Total Internal** | | 0 | 0 | 0 | 0 |
| **Total Pass-by** | | 0 | 0 | 0 | 0 |
| **Total Non-pass-by** | | 388 | 318 | 209 | 243 |

| | | Existing Uses | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Time Period** | **Movement** | **Day Care (75 Students)** | **Lesley Ellis (174 Students)** | **ECHS (65 Students)** | **75% of Lesley Ellis** | **Total** | **Future 6th Grade School** | **Net New** |
| Weekday Morning | Enter | 31 | 87 | 33 | 65 | 129 | 149 | 20 |
| Peak Hour | Exit | 27 | 71 | 27 | 53 | 107 | 121 | 14 |
| | Total | 58 | 158 | 60 | 118 | 236 | 270 | 34 |
| | | | | | | | | |
| Weekday Evening | Enter | 28 | 47 | | 35 | 63 | 68 | 5 |
| Peak Hour | Exit | 32 | 54 | | 41 | 73 | 82 | 9 |
| | Total | 60 | 101 | | 76 | 136 | 150 | 14 |
| | | | 73% | 27% | | | | |

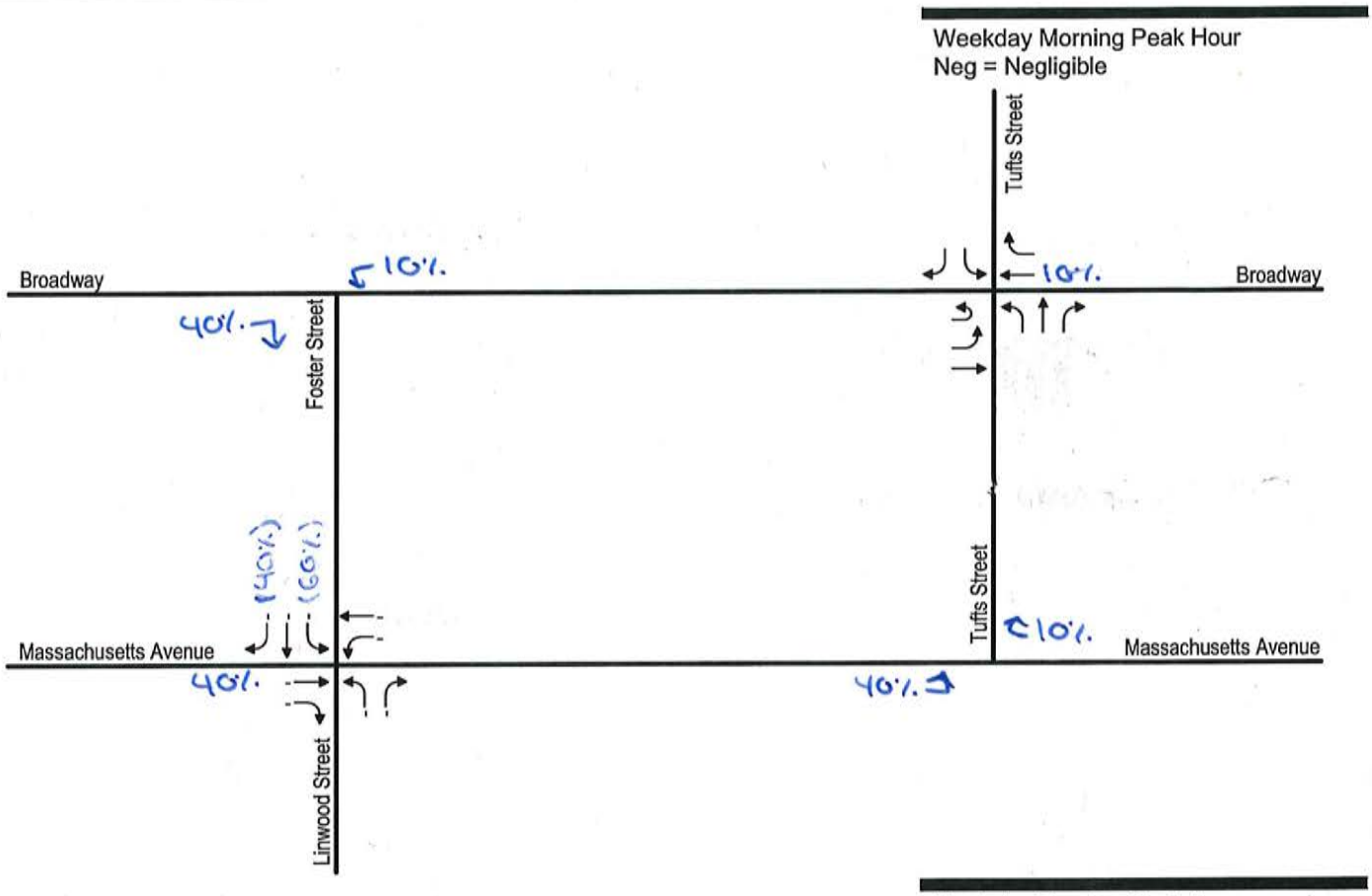
| Precinct | Grade | Students | In2Miles | Elig. For Bus | Grade | Students | In2Miles | Elig. For Bus | Grade | Students | In2Miles | Elig. For Bus | AVERAGE Students | AVERAGE In2Miles | AVERAGE Elig. For Bus |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 4 | 22 | 22 | 0 | 3 | 30 | 30 | 0 | 2 | 29 | 29 | 0 | 81 | 81 | 0 |
| **2** | 4 | 19 | 19 | 0 | 3 | 19 | 19 | 0 | 2 | 29 | 29 | 0 | 67 | 67 | 0 |
| **3** | 4 | 17 | 17 | 0 | 3 | 9 | 9 | 0 | 2 | 14 | 14 | 0 | 40 | 40 | 0 |
| **4** | 4 | 18 | 18 | 0 | 3 | 21 | 21 | 0 | 2 | 23 | 23 | 0 | 62 | 62 | 0 |
| **5** | 4 | 21 | 21 | 0 | 3 | 15 | 15 | 0 | 2 | 28 | 28 | 0 | 64 | 64 | 0 |
| **6** | 4 | 14 | 14 | 0 | 3 | 13 | 13 | 0 | 2 | 16 | 16 | 0 | 43 | 43 | 0 |
| **7** | 4 | 24 | 24 | 0 | 3 | 22 | 22 | 0 | 2 | 18 | 18 | 0 | 64 | 64 | 0 |
| **8** | 4 | 10 | 10 | 0 | 3 | 23 | 23 | 0 | 2 | 11 | 11 | 0 | 44 | 44 | 0 |
| **9** | 4 | 15 | 15 | 0 | 3 | 14 | 14 | 0 | 2 | 12 | 12 | 0 | 41 | 41 | 0 |
| **10** | 4 | 20 | 16 | 4 | 3 | 23 | 22 | 1 | 2 | 32 | 30 | 2 | 75 | 68 | 7 |
| **11** | 4 | 22 | 22 | 0 | 3 | 27 | 27 | 0 | 2 | 28 | 28 | 0 | 77 | 77 | 0 |
| **12** | 4 | 32 | 13 | 19 | 3 | 27 | 8 | 19 | 2 | 40 | 10 | 30 | 99 | 31 | 68 |
| **13** | 4 | 29 | 13 | 16 | 3 | 24 | 9 | 15 | 2 | 23 | 9 | 14 | 76 | 31 | 45 |
| **14** | 4 | 15 | 12 | 3 | 3 | 32 | 24 | 8 | 2 | 30 | 25 | 5 | 77 | 61 | 16 |
| **15** | 4 | 40 | 25 | 15 | 3 | 27 | 20 | 7 | 2 | 26 | 18 | 8 | 93 | 63 | 30 |
| **16** | 4 | 24 | 0 | 24 | 3 | 26 | 0 | 26 | 2 | 23 | 0 | 23 | 73 | 0 | 73 |
| **17** | 4 | 14 | 12 | 2 | 3 | 15 | 14 | 1 | 2 | 15 | 13 | 2 | 44 | 39 | 5 |
| **18** | 4 | 27 | 0 | 27 | 3 | 30 | 0 | 30 | 2 | 39 | 0 | 39 | 96 | 0 | 96 |
| **19** | 4 | 22 | 0 | 22 | 3 | 31 | 2 | 29 | 2 | 19 | 0 | 19 | 72 | 2 | 70 |
| **20** | 4 | 22 | 0 | 22 | 3 | 19 | 0 | 19 | 2 | 18 | 0 | 18 | 59 | 0 | 59 |
| **21** | 4 | 22 | 0 | 22 | 3 | 27 | 0 | 27 | 2 | 23 | 0 | 23 | 72 | 0 | 72 |
| Total | | **449** | **273** | **176** | | **474** | **292** | **182** | | **496** | **313** | **183** | **1419** | **878** | **541** |
| % | | | **61%** | **39%** | | | **62%** | **38%** | | | **63%** | **37%** | | **62%** | **38%** |

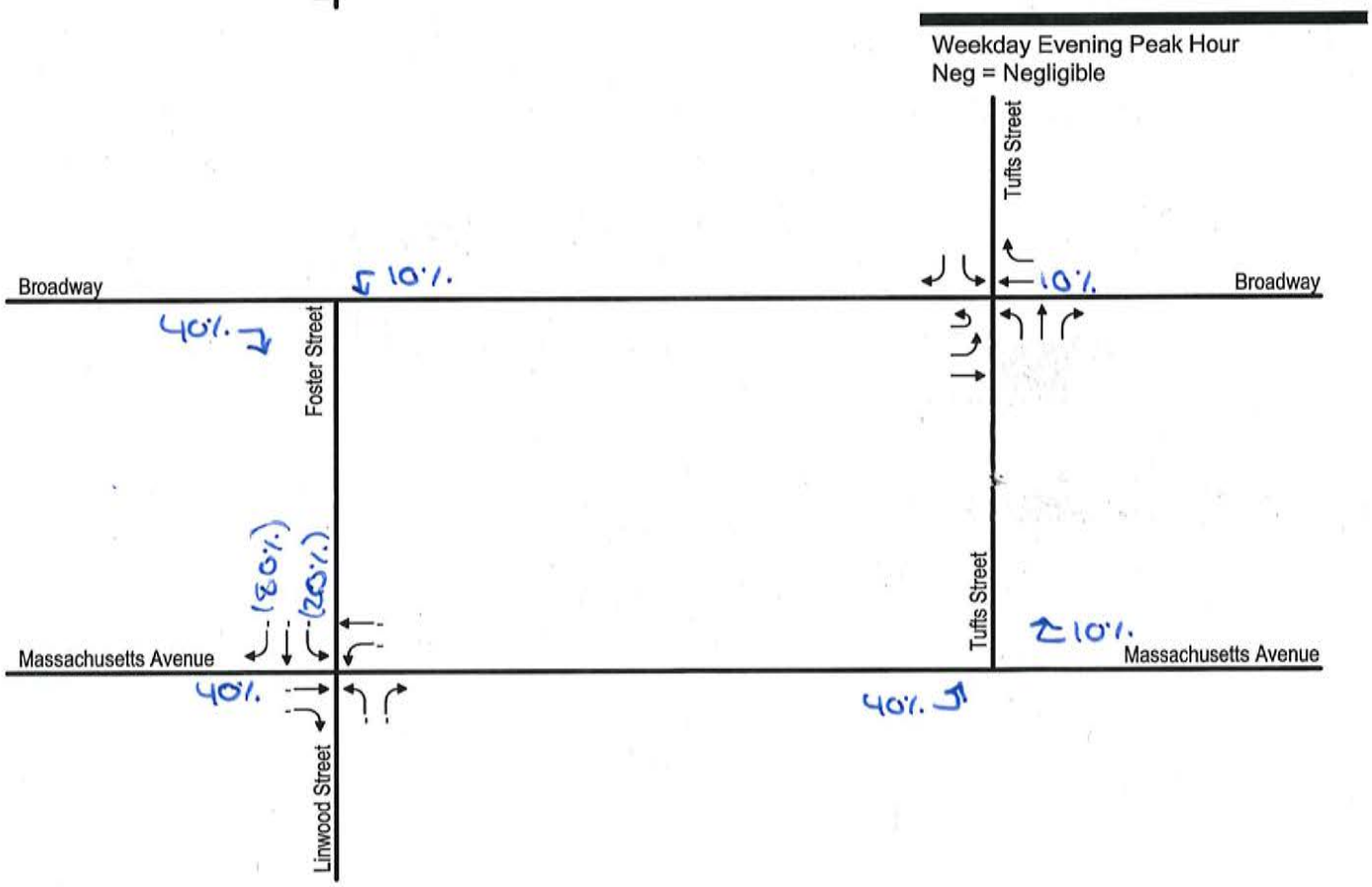
| Precinct | Students | Eligible for Bussing # | Eligible for Walking % | Eligible for Walking # | Existing Dist. Mass Ave % | Existing Dist. Mass Ave # | Existing Dist. Broadway % | Existing Dist. Broadway # |
|---|---|---|---|---|---|---|---|---|
| 1 | 81 | | 100% | 81 | | | 100% | 81 |
| 2 | 67 | | 50% | 33.5 | 100% | 67 | | |
| 3 | 40 | | 100% | 40 | 50% | 20 | 50% | 20 |
| 4 | 62 | | 50% | 31 | 100% | 62 | | |
| 5 | 64 | | 100% | 64 | | | 100% | 64 |
| 6 | 43 | | 100% | 43 | 100% | 43 | | |
| 7 | 64 | | 100% | 64 | | | 100% | 64 |
| 8 | 44 | | | | 100% | 44 | | |
| 9 | 41 | | | | | | 100% | 41 |
| 10 | 75 | 7 | | | 100% | 75 | | |
| 11 | 77 | | | | 100% | 77 | | |
| 12 | 99 | 68 | | | 100% | 99 | | |
| 13 | 76 | 45 | | | 100% | 76 | | |
| 14 | 77 | 16 | | | 100% | 77 | | |
| 15 | 93 | 30 | | | 100% | 93 | | |
| 16 | 73 | 73 | | | 100% | 73 | | |
| 17 | 44 | 5 | | | 100% | 44 | | |
| 18 | 96 | 96 | | | 100% | 96 | | |
| 19 | 72 | 70 | | | 100% | 72 | | |
| 20 | 59 | 59 | | | 100% | 59 | | |
| 21 | 72 | 72 | | | 100% | 72 | | |
| | **1,419** | **541** | | **357** | | **1,149** | | **270** |
| | | | | **25%** | | **81%** | | **19%** |

| | % | # |
|---|---|---|
| Students | 100% | 500 |
| Students Ellible for Bussing | 38% | 190 |
| Students Able to Walk | 25% | 125 |
| | | |
| After School Program | | 75 |

| | High Estimate | | | Low Estimate | |
|---|---|---|---|---|---|
| % Bussing: | 19% | 95 | % Bussing: | 38% | 190 |
| % Walking: | 10% | 50 | % Walking: | 25% | 125 |
| Net Students: | | 355 | | | 185 |
| Ave Queue | 601 | | Ave Queue | 318 | |
| Max Queue | 781 | | Max Queue | 414 | |

# Trip Distribution




vhb

PROD DIST.

The Gibbs School
Arlington, Massachusetts

November 2016

# Capacity Analysis Worksheets

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 770 | 10 | 10 | 440 | 0 | 15 | 0 | 5 | 30 | 5 | 20 | |
| Future Volume (vph) | 0 | 770 | 10 | 10 | 440 | 0 | 15 | 0 | 5 | 30 | 5 | 20 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3429 | 0 | 0 | 1791 | 0 | 0 | 1771 | 0 | 0 | 1662 | 0 | |
| Flt Permitted | | | | | 0.979 | | | 0.819 | | | 0.820 | | |
| Satd. Flow (perm) | 0 | 3429 | 0 | 0 | 1755 | 0 | 0 | 1506 | 0 | 0 | 1400 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 2 | | | | | | 39 | | | 13 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 47 | | | 16 | | | | | | 13 | |
| Peak Hour Factor | 0.94 | 0.94 | 0.94 | 0.89 | 0.89 | 0.89 | 0.92 | 0.92 | 0.92 | 0.88 | 0.88 | 0.88 | |
| Heavy Vehicles (%) | 5% | 5% | 5% | 6% | 6% | 6% | 0% | 0% | 0% | 2% | 2% | 2% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 830 | 0 | 0 | 505 | 0 | 0 | 21 | 0 | 0 | 63 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | . | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 75.9 | | | 75.9 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.71 | | | 0.71 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.34 | | | 0.40 | | | 0.12 | | | 0.44 | | |
| Control Delay | | 9.5 | | | 11.3 | | | 7.7 | | | 51.1 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 9.5 | | | 11.3 | | | 7.7 | | | 51.1 | | |
| LOS | | A | | | B | | | A | | | D | | |
| Approach Delay | | 9.5 | | | 11.3 | | | 7.7 | | | 51.1 | | |
| Approach LOS | | A | | | B | | | A | | | D | | |
| Queue Length 50th (ft) | | 159 | | | 197 | | | 0 | | | 36 | | |
| Queue Length 95th (ft) | | 201 | | | 275 | | | 13 | | | 81 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3429 | | | 1755 | | | 178 | | | 144 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.24 | | | 0.29 | | | 0.12 | | | 0.44 | | |

**Intersection Summary**

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 106.8
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.44
Intersection Signal Delay: 12.0 Intersection LOS: B
Intersection Capacity Utilization 78.3% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.6 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 285 | 0 | 0 | 305 | 5 | 15 | 15 | 35 | 15 | 0 | 5 |
| Future Vol, veh/h | 5 | 285 | 0 | 0 | 305 | 5 | 15 | 15 | 35 | 15 | 0 | 5 |
| Conflicting Peds, #/hr | 11 | 0 | 30 | 30 | 0 | 11 | 11 | 0 | 0 | 0 | 0 | 11 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 77 | 77 | 77 | 72 | 72 | 72 | 59 | 59 | 59 | 61 | 61 | 61 |
| Heavy Vehicles, % | 5 | 5 | 5 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 6 | 370 | 0 | 0 | 424 | 7 | 25 | 25 | 59 | 25 | 0 | 8 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 442 | 0 | - | - | - | 0 | 825 | 825 | 370 | 863 | 821 | 449 |
| Stage 1 | - | - | - | - | - | - | 383 | 383 | - | 438 | 438 | - |
| Stage 2 | - | - | - | - | - | - | 442 | 442 | - | 425 | 383 | - |
| Critical Hdwy | 4.15 | - | - | - | - | - | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.245 | - | - | - | - | - | 3.5 | 4 | 3.3 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1102 | - | 0 | 0 | - | - | 294 | 310 | 680 | 277 | 312 | 614 |
| Stage 1 | - | - | 0 | 0 | - | - | 644 | 616 | - | 601 | 582 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 598 | 580 | - | 611 | 616 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1090 | - | - | - | - | - | 285 | 305 | 680 | 233 | 307 | 601 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 285 | 305 | - | 233 | 307 | - |
| Stage 1 | - | - | - | - | - | - | 639 | 612 | - | 591 | 576 | - |
| Stage 2 | - | - | - | - | - | - | 584 | 574 | - | 531 | 612 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 16.4 | 19.9 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 424 | 1090 | - | - | - | 275 |
| HCM Lane V/C Ratio | 0.26 | 0.006 | - | - | - | 0.119 |
| HCM Control Delay (s) | 16.4 | 8.3 | 0 | - | - | 19.9 |
| HCM Lane LOS | C | A | A | - | - | C |
| HCM 95th %tile Q(veh) | 1 | 0 | - | - | - | 0.4 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 485 | 25 | 25 | 465 | 0 | 10 | 0 | 15 | 20 | 5 | 15 | |
| Future Volume (vph) | 0 | 485 | 25 | 25 | 465 | 0 | 10 | 0 | 15 | 20 | 5 | 15 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3378 | 0 | 0 | 1804 | 0 | 0 | 1711 | 0 | 0 | 1745 | 0 | |
| Flt Permitted | | | | | 0.953 | | | 0.847 | | | 0.825 | | |
| Satd. Flow (perm) | 0 | 3378 | 0 | 0 | 1724 | 0 | 0 | 1477 | 0 | 0 | 1475 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 8 | | | | | | 39 | | | 14 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 9 | | | 13 | | | | | | 1 | |
| Peak Hour Factor | 0.88 | 0.88 | 0.88 | 0.89 | 0.89 | 0.89 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Heavy Vehicles (%) | 6% | 6% | 6% | 5% | 5% | 5% | 0% | 0% | 0% | 0% | 0% | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 579 | 0 | 0 | 550 | 0 | 0 | 33 | 0 | 0 | 54 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 75.9 | | | 75.9 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.68 | | | 0.68 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.25 | | | 0.47 | | | 0.20 | | | 0.37 | | |
| Control Delay | | 9.8 | | | 13.6 | | | 15.7 | | | 47.2 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 9.8 | | | 13.6 | | | 15.7 | | | 47.2 | | |
| LOS | | A | | | B | | | B | | | D | | |
| Approach Delay | | 9.8 | | | 13.6 | | | 15.7 | | | 47.3 | | |
| Approach LOS | | A | | | B | | | B | | | D | | |
| Queue Length 50th (ft) | | 100 | | | 224 | | | 0 | | | 29 | | |
| Queue Length 95th (ft) | | 128 | | | 313 | | | 18 | | | 56 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3378 | | | 1724 | | | 169 | | | 146 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.17 | | | 0.32 | | | 0.20 | | | 0.37 | | |

**Intersection Summary**

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 111.2
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.47
Intersection Signal Delay: 13.4 Intersection LOS: B
Intersection Capacity Utilization 78.3% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.3 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 10 | 170 | 0 | 0 | 200 | 0 | 20 | 10 | 30 | 10 | 0 | 10 |
| Future Vol, veh/h | 10 | 170 | 0 | 0 | 200 | 0 | 20 | 10 | 30 | 10 | 0 | 10 |
| Conflicting Peds, #/hr | 38 | 0 | 25 | 25 | 0 | 38 | 8 | 0 | 0 | 0 | 0 | 8 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 79 | 79 | 79 | 83 | 83 | 83 | 85 | 85 | 85 | 68 | 68 | 68 |
| Heavy Vehicles, % | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 |
| Mvmt Flow | 13 | 215 | 0 | 0 | 241 | 0 | 24 | 12 | 35 | 15 | 0 | 15 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 279 | 0 | - | - | - | 0 | 497 | 520 | 215 | 543 | 520 | 287 |
| Stage 1 | - | - | - | - | - | - | 241 | 241 | - | 279 | 279 | - |
| Stage 2 | - | - | - | - | - | - | 256 | 279 | - | 264 | 241 | - |
| Critical Hdwy | 4.14 | - | - | - | - | - | 7.15 | 6.55 | 6.25 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.236 | - | - | - | - | - | 3.545 | 4.045 | 3.345 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1272 | - | 0 | 0 | - | - | 479 | 456 | 817 | 454 | 463 | 757 |
| Stage 1 | - | - | 0 | 0 | - | - | 756 | 701 | - | 732 | 683 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 742 | 674 | - | 746 | 710 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1262 | - | - | - | - | - | 461 | 434 | 817 | 406 | 441 | 724 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 461 | 434 | - | 406 | 441 | - |
| Stage 1 | - | - | - | - | - | - | 747 | 693 | - | 697 | 658 | - |
| Stage 2 | - | - | - | - | - | - | 721 | 650 | - | 693 | 701 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.4 | 0 | 12 | 12.3 |
| HCM LOS | | | B | B |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 582 | 1262 | - | - | - | 520 |
| HCM Lane V/C Ratio | 0.121 | 0.01 | - | - | - | 0.057 |
| HCM Control Delay (s) | 12 | 7.9 | 0 | - | - | 12.3 |
| HCM Lane LOS | B | A | A | - | - | B |
| HCM 95th %tile Q(veh) | 0.4 | 0 | - | - | - | 0.2 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 825 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 30 | 5 | 20 | |
| Future Volume (vph) | 0 | 825 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 30 | 5 | 20 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3429 | 0 | 0 | 1791 | 0 | 0 | 1771 | 0 | 0 | 1659 | 0 | |
| Flt Permitted | | | | | 0.977 | | | 0.794 | | | 0.817 | | |
| Satd. Flow (perm) | 0 | 3429 | 0 | 0 | 1751 | 0 | 0 | 1460 | 0 | 0 | 1393 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 2 | | | | | | 39 | | | 13 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 47 | | | 16 | | | | | | 13 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 5% | 5% | 5% | 6% | 6% | 6% | 0% | 0% | 0% | 2% | 2% | 2% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 908 | 0 | 0 | 522 | 0 | 0 | 21 | 0 | 0 | 60 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 75.9 | | | 75.9 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.71 | | | 0.71 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.37 | | | 0.42 | | | 0.12 | | | 0.42 | | |
| Control Delay | | 9.9 | | | 11.5 | | | 7.8 | | | 50.1 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 9.9 | | | 11.5 | | | 7.8 | | | 50.1 | | |
| LOS | | A | | | B | | | A | | | D | | |
| Approach Delay | | 9.9 | | | 11.5 | | | 7.8 | | | 50.1 | | |
| Approach LOS | | A | | | B | | | A | | | D | | |
| Queue Length 50th (ft) | | 180 | | | 207 | | | 0 | | | 34 | | |
| Queue Length 95th (ft) | | 225 | | | 293 | | | 13 | | | 79 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3429 | | | 1751 | | | 173 | | | 143 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.26 | | | 0.30 | | | 0.12 | | | 0.42 | | |

| Intersection Summary | | | |
|---|---|---|---|
| Area Type: | Other | | |
| Cycle Length: 166 | | | |
| Actuated Cycle Length: 106.8 | | | |
| Natural Cycle: 120 | | | |
| Control Type: Actuated-Uncoordinated | | | |
| Maximum v/c Ratio: 0.42 | | | |
| Intersection Signal Delay: 12.0 | | Intersection LOS: B | |
| Intersection Capacity Utilization 78.3% | | ICU Level of Service D | |
| Analysis Period (min) 15 | | | |

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 305 | 0 | 0 | 325 | 5 | 15 | 15 | 40 | 15 | 0 | 5 |
| Future Vol, veh/h | 5 | 305 | 0 | 0 | 325 | 5 | 15 | 15 | 40 | 15 | 0 | 5 |
| Conflicting Peds, #/hr | 11 | 0 | 30 | 30 | 0 | 11 | 11 | 0 | 0 | 0 | 0 | 11 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 5 | 332 | 0 | 0 | 353 | 5 | 16 | 16 | 43 | 16 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 370 | 0 | - | - | - | 0 | 712 | 712 | 332 | 739 | 709 | 378 |
| Stage 1 | - | - | - | - | - | - | 342 | 342 | - | 367 | 367 | - |
| Stage 2 | - | - | - | - | - | - | 370 | 370 | - | 372 | 342 | - |
| Critical Hdwy | 4.15 | - | - | - | - | - | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.245 | - | - | - | - | - | 3.5 | 4 | 3.3 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1172 | - | 0 | 0 | - | - | 350 | 360 | 714 | 336 | 362 | 673 |
| Stage 1 | - | - | 0 | 0 | - | - | 677 | 642 | - | 657 | 626 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 654 | 624 | - | 653 | 642 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1160 | - | - | - | - | - | 342 | 354 | 714 | 300 | 356 | 659 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 342 | 354 | - | 300 | 356 | - |
| Stage 1 | - | - | - | - | - | - | 674 | 639 | - | 647 | 619 | - |
| Stage 2 | - | - | - | - | - | - | 642 | 617 | - | 595 | 639 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 13.7 | 16.1 |
| HCM LOS | | | B | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 492 | 1160 | - | - | - | 347 |
| HCM Lane V/C Ratio | 0.155 | 0.005 | - | - | - | 0.063 |
| HCM Control Delay (s) | 13.7 | 8.1 | 0 | - | - | 16.1 |
| HCM Lane LOS | B | A | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.5 | 0 | - | - | - | 0.2 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 520 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 20 | 5 | 15 | |
| Future Volume (vph) | 0 | 520 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 20 | 5 | 15 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3378 | 0 | 0 | 1806 | 0 | 0 | 1713 | 0 | 0 | 1743 | 0 | |
| Flt Permitted | | | | | 0.955 | | | 0.848 | | | 0.825 | | |
| Satd. Flow (perm) | 0 | 3378 | 0 | 0 | 1728 | 0 | 0 | 1482 | 0 | 0 | 1475 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 7 | | | | | | 39 | | | 14 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 9 | | | 13 | | | | | | 1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 6% | 6% | 6% | 5% | 5% | 5% | 0% | 0% | 0% | 0% | 0% | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 592 | 0 | 0 | 570 | 0 | 0 | 27 | 0 | 0 | 43 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 75.9 | | | 75.9 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.68 | | | 0.68 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.26 | | | 0.48 | | | 0.16 | | | 0.29 | | |
| Control Delay | | 9.9 | | | 13.9 | | | 11.5 | | | 42.6 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 9.9 | | | 13.9 | | | 11.5 | | | 42.6 | | |
| LOS | | A | | | B | | | B | | | D | | |
| Approach Delay | | 9.9 | | | 13.9 | | | 11.5 | | | 42.6 | | |
| Approach LOS | | A | | | B | | | B | | | D | | |
| Queue Length 50th (ft) | | 103 | | | 237 | | | 0 | | | 21 | | |
| Queue Length 95th (ft) | | 135 | | | 335 | | | 21 | | | 58 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3378 | | | 1728 | | | 169 | | | 146 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.18 | | | 0.33 | | | 0.16 | | | 0.29 | | |

**Intersection Summary**

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 111.2
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.48
Intersection Signal Delay: 12.9 Intersection LOS: B
Intersection Capacity Utilization 78.3% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 10 | 180 | 0 | 0 | 215 | 0 | 20 | 10 | 30 | 10 | 0 | 10 |
| Future Vol, veh/h | 10 | 180 | 0 | 0 | 215 | 0 | 20 | 10 | 30 | 10 | 0 | 10 |
| Conflicting Peds, #/hr | 38 | 0 | 25 | 25 | 0 | 38 | 8 | 0 | 0 | 0 | 0 | 8 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 |
| Mvmt Flow | 11 | 196 | 0 | 0 | 234 | 0 | 22 | 11 | 33 | 11 | 0 | 11 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 272 | 0 | - | - | - | 0 | 464 | 489 | 196 | 511 | 489 | 280 |
| Stage 1 | - | - | - | - | - | - | 217 | 217 | - | 272 | 272 | - |
| Stage 2 | - | - | - | - | - | - | 247 | 272 | - | 239 | 217 | - |
| Critical Hdwy | 4.14 | - | - | - | - | - | 7.15 | 6.55 | 6.25 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.236 | - | - | - | - | - | 3.545 | 4.045 | 3.345 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1280 | - | 0 | 0 | - | - | 503 | 475 | 838 | 476 | 482 | 764 |
| Stage 1 | - | - | 0 | 0 | - | - | 779 | 718 | - | 738 | 688 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 750 | 679 | - | 769 | 727 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1270 | - | - | - | - | - | 488 | 453 | 838 | 430 | 460 | 731 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 488 | 453 | - | 430 | 460 | - |
| Stage 1 | - | - | - | - | - | - | 771 | 711 | - | 704 | 663 | - |
| Stage 2 | - | - | - | - | - | - | 733 | 654 | - | 720 | 720 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.4 | 0 | 11.6 | 11.9 |
| HCM LOS | | | B | B |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 607 | 1270 | - | - | - | 541 |
| HCM Lane V/C Ratio | 0.107 | 0.009 | - | - | - | 0.04 |
| HCM Control Delay (s) | 11.6 | 7.9 | 0 | - | - | 11.9 |
| HCM Lane LOS | B | A | A | - | - | B |
| HCM 95th %tile Q(veh) | 0.4 | 0 | - | - | - | 0.1 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 795 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 90 | 5 | 60 | |
| Future Volume (vph) | 0 | 795 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 90 | 5 | 60 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3429 | 0 | 0 | 1791 | 0 | 0 | 1771 | 0 | 0 | 1650 | 0 | |
| Flt Permitted | | | | | 0.978 | | | 0.664 | | | 0.808 | | |
| Satd. Flow (perm) | 0 | 3429 | 0 | 0 | 1753 | 0 | 0 | 1221 | 0 | 0 | 1372 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 2 | | | | | | 39 | | | 15 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 47 | | | 16 | | | | | | 13 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 5% | 5% | 5% | 6% | 6% | 6% | 0% | 0% | 0% | 2% | 2% | 2% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 875 | 0 | 0 | 522 | 0 | 0 | 21 | 0 | 0 | 168 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 70.7 | | | 70.7 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.66 | | | 0.66 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.39 | | | 0.45 | | | 0.14 | | | 1.18 | | |
| Control Delay | | 10.3 | | | 12.2 | | | 8.4 | | | 172.9 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 10.3 | | | 12.2 | | | 8.4 | | | 172.9 | | |
| LOS | | B | | | B | | | A | | | F | | |
| Approach Delay | | 10.3 | | | 12.2 | | | 8.4 | | | 172.9 | | |
| Approach LOS | | B | | | B | | | A | | | F | | |
| Queue Length 50th (ft) | | 171 | | | 207 | | | 0 | | | ~149 | | |
| Queue Length 95th (ft) | | 215 | | | 293 | | | 13 | | | #291 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3429 | | | 1753 | | | 150 | | | 142 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.26 | | | 0.30 | | | 0.14 | | | 1.18 | | |

| Intersection Summary | | | |
|---|---|---|---|
| Area Type: | Other | | |
| Cycle Length: 166 | | | |
| Actuated Cycle Length: 107.2 | | | |
| Natural Cycle: 120 | | | |
| Control Type: Actuated-Uncoordinated | | | |
| Maximum v/c Ratio: 1.18 | | | |
| Intersection Signal Delay: 28.1 | | Intersection LOS: C | |
| Intersection Capacity Utilization 79.3% | | ICU Level of Service D | |
| Analysis Period (min) 15 | | | |

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.9 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 305 | 0 | 0 | 325 | 5 | 5 | 5 | 10 | 15 | 0 | 5 |
| Future Vol, veh/h | 5 | 305 | 0 | 0 | 325 | 5 | 5 | 5 | 10 | 15 | 0 | 5 |
| Conflicting Peds, #/hr | 11 | 0 | 30 | 30 | 0 | 11 | 11 | 0 | 0 | 0 | 0 | 11 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 5 | 332 | 0 | 0 | 353 | 5 | 5 | 5 | 11 | 16 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 370 | 0 | - | - | - | 0 | 712 | 712 | 332 | 718 | 709 | 378 |
| Stage 1 | - | - | - | - | - | - | 342 | 342 | - | 367 | 367 | - |
| Stage 2 | - | - | - | - | - | - | 370 | 370 | - | 351 | 342 | - |
| Critical Hdwy | 4.15 | - | - | - | - | - | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.245 | - | - | - | - | - | 3.5 | 4 | 3.3 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1172 | - | 0 | 0 | - | - | 350 | 360 | 714 | 347 | 362 | 673 |
| Stage 1 | - | - | 0 | 0 | - | - | 677 | 642 | - | 657 | 626 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 654 | 624 | - | 670 | 642 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1160 | - | - | - | - | - | 342 | 354 | 714 | 333 | 356 | 659 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 342 | 354 | - | 333 | 356 | - |
| Stage 1 | - | - | - | - | - | - | 674 | 639 | - | 647 | 619 | - |
| Stage 2 | - | - | - | - | - | - | 642 | 617 | - | 651 | 639 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 13.1 | 15 |
| HCM LOS | | | B | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 468 | 1160 | - | - | - | 380 |
| HCM Lane V/C Ratio | 0.046 | 0.005 | - | - | - | 0.057 |
| HCM Control Delay (s) | 13.1 | 8.1 | 0 | - | - | 15 |
| HCM Lane LOS | B | A | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.1 | 0 | - | - | - | 0.2 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 505 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 30 | 5 | 75 | |
| Future Volume (vph) | 0 | 505 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 30 | 5 | 75 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3378 | 0 | 0 | 1806 | 0 | 0 | 1713 | 0 | 0 | 1671 | 0 | |
| Flt Permitted | | | | | 0.956 | | | 0.754 | | | 0.897 | | |
| Satd. Flow (perm) | 0 | 3378 | 0 | 0 | 1730 | 0 | 0 | 1318 | 0 | 0 | 1520 | 0 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 8 | | | | | | 39 | | | 50 | | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 9 | | | 13 | | | | | | 1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 6% | 6% | 6% | 5% | 5% | 5% | 0% | 0% | 0% | 0% | 0% | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 576 | 0 | 0 | 570 | 0 | 0 | 27 | 0 | 0 | 120 | 0 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | | None |
| Act Effct Green (s) | | 70.5 | | | 70.5 | | | 10.1 | | | 10.1 | | |
| Actuated g/C Ratio | | 0.63 | | | 0.63 | | | 0.09 | | | 0.09 | | |
| v/c Ratio | | 0.27 | | | 0.52 | | | 0.18 | | | 0.66 | | |
| Control Delay | | 10.3 | | | 14.8 | | | 12.0 | | | 48.9 | | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | | |
| Total Delay | | 10.3 | | | 14.8 | | | 12.0 | | | 48.9 | | |
| LOS | | B | | | B | | | B | | | D | | |
| Approach Delay | | 10.3 | | | 14.8 | | | 12.0 | | | 48.9 | | |
| Approach LOS | | B | | | B | | | B | | | D | | |
| Queue Length 50th (ft) | | 100 | | | 237 | | | 0 | | | 51 | | |
| Queue Length 95th (ft) | | 131 | | | 335 | | | 21 | | | #134 | | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3378 | | | 1730 | | | 154 | | | 182 | | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | | |
| Reduced v/c Ratio | | 0.17 | | | 0.33 | | | 0.18 | | | 0.66 | | |

Intersection Summary

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 111.6
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.66
Intersection Signal Delay: 15.9 Intersection LOS: B
Intersection Capacity Utilization 78.3% ICU Level of Service D
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Intersection | |
|---|---|
| Int Delay, s/veh | 1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 10 | 180 | 0 | 0 | 215 | 0 | 2 | 5 | 5 | 10 | 0 | 10 |
| Future Vol, veh/h | 10 | 180 | 0 | 0 | 215 | 0 | 2 | 5 | 5 | 10 | 0 | 10 |
| Conflicting Peds, #/hr | 38 | 0 | 25 | 25 | 0 | 38 | 8 | 0 | 0 | 0 | 0 | 8 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 |
| Mvmt Flow | 11 | 196 | 0 | 0 | 234 | 0 | 2 | 5 | 5 | 11 | 0 | 11 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 272 | 0 | - | - | - | 0 | 464 | 489 | 196 | 495 | 489 | 280 |
| Stage 1 | - | - | - | - | - | - | 217 | 217 | - | 272 | 272 | - |
| Stage 2 | - | - | - | - | - | - | 247 | 272 | - | 223 | 217 | - |
| Critical Hdwy | 4.14 | - | - | - | - | - | 7.15 | 6.55 | 6.25 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.236 | - | - | - | - | - | 3.545 | 4.045 | 3.345 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1280 | - | 0 | 0 | - | - | 503 | 475 | 838 | 488 | 482 | 764 |
| Stage 1 | - | - | 0 | 0 | - | - | 779 | 718 | - | 738 | 688 | - |
| Stage 2 | - | - | 0 | 0 | - | - | 750 | 679 | - | 784 | 727 | - |
| Platoon blocked, % | | - | | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1270 | - | - | - | - | - | 488 | 453 | 838 | 459 | 460 | 731 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 488 | 453 | - | 459 | 460 | - |
| Stage 1 | - | - | - | - | - | - | 771 | 711 | - | 704 | 663 | - |
| Stage 2 | - | - | - | - | - | - | 733 | 654 | - | 765 | 720 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.4 | 0 | 11.5 | 11.6 |
| HCM LOS | | | B | B |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 569 | 1270 | - | - | - | 564 |
| HCM Lane V/C Ratio | 0.023 | 0.009 | - | - | - | 0.039 |
| HCM Control Delay (s) | 11.5 | 7.9 | 0 | - | - | 11.6 |
| HCM Lane LOS | B | A | A | - | - | B |
| HCM 95th %tile Q(veh) | 0.1 | 0 | - | - | - | 0.1 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 795 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 90 | 5 | 60 | |
| Future Volume (vph) | 0 | 795 | 10 | 10 | 470 | 0 | 15 | 0 | 5 | 90 | 5 | 60 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3429 | 0 | 0 | 1791 | 0 | 0 | 1771 | 0 | 0 | 1779 | 1583 | |
| Flt Permitted | | | | | 0.978 | | | 0.723 | | | 0.721 | | |
| Satd. Flow (perm) | 0 | 3429 | 0 | 0 | 1753 | 0 | 0 | 1330 | 0 | 0 | 1343 | 1454 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 2 | | | | | | 39 | | | | 65 | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 47 | | | 16 | | | | | | 13 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 5% | 5% | 5% | 6% | 6% | 6% | 0% | 0% | 0% | 2% | 2% | 2% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 875 | 0 | 0 | 522 | 0 | 0 | 21 | 0 | 0 | 103 | 65 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | 4 | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | 4 | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | 17.0 | 22.0 |
| Total Split (s) | | 124.0 | | 124.0 | 124.0 | | 20.0 | 20.0 | | 20.0 | 20.0 | 20.0 | 22.0 |
| Total Split (%) | | 74.7% | | 74.7% | 74.7% | | 12.0% | 12.0% | | 12.0% | 12.0% | 12.0% | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | 7.0 | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | None | None |
| Act Effct Green (s) | | 70.7 | | | 70.7 | | | 13.1 | | | 13.1 | 13.1 | |
| Actuated g/C Ratio | | 0.64 | | | 0.64 | | | 0.12 | | | 0.12 | 0.12 | |
| v/c Ratio | | 0.40 | | | 0.46 | | | 0.11 | | | 0.65 | 0.28 | |
| Control Delay | | 11.6 | | | 13.6 | | | 7.0 | | | 68.6 | 15.4 | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | |
| Total Delay | | 11.6 | | | 13.6 | | | 7.0 | | | 68.6 | 15.4 | |
| LOS | | B | | | B | | | A | | | E | B | |
| Approach Delay | | 11.6 | | | 13.6 | | | 7.0 | | | 48.0 | | |
| Approach LOS | | B | | | B | | | A | | | D | | |
| Queue Length 50th (ft) | | 184 | | | 222 | | | 0 | | | 78 | 0 | |
| Queue Length 95th (ft) | | 230 | | | 314 | | | 12 | | | #164 | 43 | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3394 | | | 1735 | | | 193 | | | 159 | 230 | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Reduced v/c Ratio | | 0.26 | | | 0.30 | | | 0.11 | | | 0.65 | 0.28 | |

**Intersection Summary**

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 110.2
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.65
Intersection Signal Delay: 16.0 Intersection LOS: B
Intersection Capacity Utilization 92.5% ICU Level of Service F
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

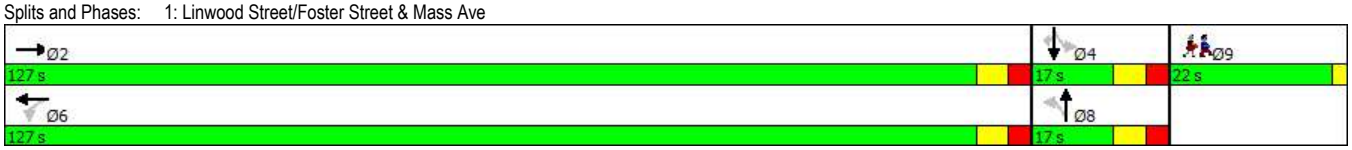
Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR | Ø9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 505 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 30 | 5 | 75 | |
| Future Volume (vph) | 0 | 505 | 25 | 25 | 500 | 0 | 10 | 0 | 15 | 30 | 5 | 75 | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | |
| Satd. Flow (prot) | 0 | 3378 | 0 | 0 | 1806 | 0 | 0 | 1713 | 0 | 0 | 1820 | 1615 | |
| Flt Permitted | | | | | 0.956 | | | 0.850 | | | 0.735 | | |
| Satd. Flow (perm) | 0 | 3378 | 0 | 0 | 1730 | 0 | 0 | 1486 | 0 | 0 | 1396 | 1573 | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes | |
| Satd. Flow (RTOR) | | 8 | | | | | | 39 | | | | 82 | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | | |
| Link Distance (ft) | | 1016 | | | 856 | | | 666 | | | 1027 | | |
| Travel Time (s) | | 23.1 | | | 19.5 | | | 15.1 | | | 23.3 | | |
| Confl. Bikes (#/hr) | | | 9 | | | 13 | | | | | | 1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | |
| Heavy Vehicles (%) | 6% | 6% | 6% | 5% | 5% | 5% | 0% | 0% | 0% | 0% | 0% | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 576 | 0 | 0 | 570 | 0 | 0 | 27 | 0 | 0 | 38 | 82 | |
| Turn Type | | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm | |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | | 9 |
| Permitted Phases | | | | 6 | | | 8 | | | 4 | | 4 | |
| Detector Phase | | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | 4 | |
| Switch Phase | | | | | | | | | | | | | |
| Minimum Initial (s) | | 70.0 | | 70.0 | 70.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 | 7.0 |
| Minimum Split (s) | | 77.0 | | 77.0 | 77.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | 17.0 | 22.0 |
| Total Split (s) | | 127.0 | | 127.0 | 127.0 | | 17.0 | 17.0 | | 17.0 | 17.0 | 17.0 | 22.0 |
| Total Split (%) | | 76.5% | | 76.5% | 76.5% | | 10.2% | 10.2% | | 10.2% | 10.2% | 10.2% | 13% |
| Yellow Time (s) | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 2.0 |
| All-Red Time (s) | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 0.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 7.0 | | | 7.0 | | | 7.0 | | | 7.0 | 7.0 | |
| Lead/Lag | | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | | |
| Recall Mode | | Min | | Min | Min | | None | None | | None | None | None | None |
| Act Effct Green (s) | | 72.0 | | | 72.0 | | | 10.0 | | | 10.0 | 10.0 | |
| Actuated g/C Ratio | | 0.64 | | | 0.64 | | | 0.09 | | | 0.09 | 0.09 | |
| v/c Ratio | | 0.27 | | | 0.52 | | | 0.16 | | | 0.31 | 0.38 | |
| Control Delay | | 10.3 | | | 14.7 | | | 11.6 | | | 57.0 | 16.4 | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | |
| Total Delay | | 10.3 | | | 14.7 | | | 11.6 | | | 57.0 | 16.4 | |
| LOS | | B | | | B | | | B | | | E | B | |
| Approach Delay | | 10.3 | | | 14.7 | | | 11.6 | | | 29.3 | | |
| Approach LOS | | B | | | B | | | B | | | C | | |
| Queue Length 50th (ft) | | 100 | | | 237 | | | 0 | | | 27 | 0 | |
| Queue Length 95th (ft) | | 131 | | | 335 | | | 21 | | | 63 | 49 | |
| Internal Link Dist (ft) | | 936 | | | 776 | | | 586 | | | 947 | | |
| Turn Bay Length (ft) | | | | | | | | | | | | | |
| Base Capacity (vph) | | 3378 | | | 1730 | | | 166 | | | 123 | 214 | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | 0 | |
| Reduced v/c Ratio | | 0.17 | | | 0.33 | | | 0.16 | | | 0.31 | 0.38 | |

**Intersection Summary**

Area Type: Other
Cycle Length: 166
Actuated Cycle Length: 113.2
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.52
Intersection Signal Delay: 14.0 Intersection LOS: B
Intersection Capacity Utilization 92.5% ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 1: Linwood Street/Foster Street & Mass Ave



# Queue Figures

\\vhb\proj\Wat-TS\13682.00\graphics\FIGURES


- Drop-off only  on the east side of Foster Street; available stacking length of approximately 36 cars

**Figure A-1**

Drop-Off Configuration 1
The Gibbs School
Arlington, Massachusetts

November 2016


- Drop-off on both east & west sides of Foster Street; available stacking length of approximately 36 x 2 = 72 cars

**Figure A-2**

Drop-Off Configuration 2
The Gibbs School
Arlington, Massachusetts

November 2016


- Drop-off on the east side of Foster Street and on the south side of the building, entering via Tufts Street; available stacking length of approximately 30 + 28 = 58 cars

**Figure A-3**

Drop-Off Configuration 3
The Gibbs School
Arlington, Massachusetts

November 2016

## Appendix D – Acoustical Report

ACENTECH

33 Moulton Street
Cambridge MA 02138
617 499 8000
acentech.com

23 November 2016

Regan Shields Ives, Principal
Finegold Alexander Architects
77 N. Washington, 7th Floor
Boston, MA 02114
rshields-ives@faainc.com

Subject: Schematic Design Acoustics Narrative
Arlington Gibbs School
Acentech Project 624855

Dear Regan:

We have reviewed the progress SD drawings that you sent to us on 11 November 2016. This narrative discusses our comments and recommendations. We have attached brochures for the products recommended herein.

## ACOUSTICAL REQUIREMENTS

LEED 2009: The project is pursuing 2009 LEED for Schools Certified. IEQ Prerequisite 3 (Minimum Acoustical Performance) requires that classrooms and core learning spaces be designed to meet the following minimum requirements:

A. The HVAC system must be designed for a maximum background noise level of 45 dBA.

B. Spaces with a room volume that is less than 20,000 cubic feet must have a total quantity of sound-absorptive surface finishes that meets or exceeds the ceiling area (excluding lights, diffusers, and grilles). To qualify as “absorptive”, the finishes must have a minimum acoustical rating of Noise Reduction Coefficient (NRC) 0.70.

   Spaces with a room volume that is equal to or greater than 20,000 cubic feet must be designed per the guidelines of ANSI Standard S12.60-2002 – Acoustical Performance Criteria, Design Requirements and Guidelines for Schools to have a maximum reverberation time of 1.5 seconds.

If the Owner chooses to pursue IEQ Credit 9 (Enhanced Acoustical Performance), then the building shell, classroom partitions, and other core learning space partitions must meet the sound transmission class (STC) requirements of ANSI Standard S12.60-2002 – Acoustical Performance Criteria, Design Requirements and Guidelines for Schools, except windows, which must meet an acoustical rating of at least STC 35. Also, the HVAC system must be designed for a maximum background noise level of 40 dBA. The cost associated with changing the interior noise limit from 45 dBA to 40 dBA would be minimal, but we expect that this credit will be cost-prohibitive due to the sound isolation requirements.

# ACOUSTICAL RECOMMENDATIONS

## HVAC NOISE CONTROL

### Interior

1. Noise limit/goal: We will review the proposed HVAC system during the Design Development phase. Where necessary, we will recommend noise control measures to limit the background noise level in classrooms and core learning spaces to 45 dBA maximum. Where possible, our recommendations will aim to limit the background noise levels to 30-35 dBA, which is more suitable for classrooms and core learning spaces.

### Exterior

2. Noise limit: The noise limit in the Arlington noise ordinance is too lax to be useful for most projects, including this one. Jim Feeney, Assistant Town Manager of Arlington, recommends that we instead follow the guidelines of the Massachusetts Department of Environmental Protection, which limits noise of new HVAC equipment to 10 decibels above the current ambient at the property line. On 21 November 2016 at approximately 6:30 pm, we measured an ambient sound level ($L_{90}$) of 45-47 dBA at the School's property line. Therefore, we will review the proposed HVAC system during the Design Development phase, and where necessary we will recommend noise control measures to limit the noise level at the property line to 55 dBA maximum.

## REVERBERATION CONTROL

3. Lay-in ceilings: We understand that the project design will include lay-in ceilings in most rooms. In all classrooms and most core learning spaces, we recommend that the ACT be similar to Armstrong *Ultima*. In the Library, to minimize distracting noise and to meet the requirements of LEED, we recommend that the ACT be similar to Armstrong *Optima*.

4. Music Room 140: We will speak with the music faculty during the Design Development phase to confirm their assessment of the current facility. Typically these rooms have approximately 70% to 80% of their available wall and ceiling area treated with thick sound-absorptive materials, to control sound buildup, and the remaining 20% to 30% of the available area is treated with sound-diffusive materials, to facilitate communication between the student musicians. The quantity and layout of these materials can be adjusted to suit the preferences of the School's faculty.

## SOUND ISOLATION

As discussed above, we presume that fully LEED-compliant sound isolation will be cost-prohibitive. Therefore, the following recommendations aim to balance reasonable sound isolation with affordability.

5. Operable demising partitions: We recommend that you select a product with a minimum acoustical rating of at least STC 50, and if possible, STC 55.

6. Permanent demising partitions: We recommend that typical demising partitions of classrooms and core learning spaces have two layers of 5/8" GWB per side and glass fiber batt insulation in the stud cavity.

7. Communicating doors: Where demising partitions will include doors, at a minimum we would recommend that the doors have full perimeter adjustable gaskets similar to Zero International *770* and Zero International *360*. If possible, we would recommend sound control doors rated STC 40-50.

8. Corridor partitions: If the studs can be light gauge (e.g., 25 ga.), then one layer of 5/8" GWB will be sufficient for sound isolation. However, if heavier gauge studs (e.g., 20 ga.) will be required, then we would recommend that you add one more layer of GWB to one side of each partition.

9. Student lockers: Where student lockers abut classrooms and core learning spaces, we recommend that you avoid rigid contact between the lockers and the corridor partitions. Provide at least a 1" air gap between the lockers and the corridor partitions. If necessary, provide resilient sway braces (e.g., Mason Industries *WIC*) at the top of the lockers for lateral support.

10. Corridor doors: At a minimum, we would recommend that entrances to classrooms and core learning spaces be outfitted with modest door gaskets similar to Zero International *328*. If the class schedule will not be fully synchronized (i.e., some students will be circulating while other students are in class), and presuming that these doors will indeed be closed during classes, then we would recommend full perimeter adjustable gaskets similar to Zero International *770* and Zero International *360.*

11. Mechanical Room 115: We will review the proposed HVAC system during the Design Development phase to determine whether a GWB sound-barrier ceiling is required for this room.

## IMPACT INSULATION

12. Resilient underlayments: During the Design Development phase, we will return to the site to measure the Impact Insulation Class (IIC) rating of a typical classroom floor. We anticipate that a vinyl-based finish floor and a mineral fiber lay-in ceiling in the space below will be marginally sufficient. However, if the Owner prefers better than typical impact insulation, then they could invest in a vinyl-compatible resilient underlayment, such as Impacta *Jumpax*. Impacta also offers their *VC300* underlayment, which is somewhat more affordable, but it is not quite as durable and may not be as appropriate for this application.

This concludes our narrative. Please do not hesitate to call me with any questions (617-499-8043).

Sincerely yours,

ACENTECH INCORPORATED

Thomas J. McGraw, LEED AP
Senior Consultant

Enclosures:
Armstrong *Ultima* cutsheet
Armstrong *Optima* cutsheet
Zero International *770* cutsheet
Zero International *360* cutsheet
Mason Industries *WIC* cutsheet
Zero International *328* cutsheet
Impacta *Jumpax* cutsheet
Impacta *VC300* cutsheet

# ULTIMA®

## Tegular

fine texture

10-YEAR Availability

Items 1911, 1912, 1914, 1915

Ultima Beveled Tegular with Suprafine® 9/16" Exposed Tee grid

Ultima Beveled Tegular with Sonata™ 9/16" Dimensional Tee grid

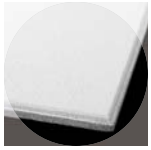
### Key Selection Attributes

- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Excellent sound absorption
- High recycled content options – items 1911HRC, 1912HRC, 1914HRC and 1915HRC – 65% pre-consumer, 15% post-consumer
- 30-Year Limited System Warranty against visible sag (excludes item 1905), mold/mildew and bacterial growth
- Visual coordinates with OPTIMA® for mixed (open/closed plan) applications
- Non-directional visual reduces installation time and scrap
- Compatible with the TECHZONE™ Ceiling Systems. Items 1905, 1911, 1912, 1914, 1915 only.
- Smaller size panels available (1 carton min. order). Info: armstrong.com/specials
- Excellent sound blocking – items 1951, 1952
- Plank sizes available (search: ultima plank)

### Typical Applications

- Offices
- Healthcare – assists in addressing HIPAA requirements
- Classrooms
- Corridors
- Lobbies/reception areas
- Department stores/retail

### Detail



ULTIMA
Beveled Tegular

ULTIMA with
SUPRAFINE 9/16"
Exposed Tee grid

ULTIMA with
SILHOUETTE® XL 9/16"
Bolt-Slot 1/4" Reveal grid

### Color

White (WH)

Armstrong®

# ULTIMA®

## Tegular

fine texture

**Recycled Content:** 51-80% armstrong.com/greengenie

**LEED® Credits**

| Energy | Waste Mgmt | Recycled Content | Local Materials | Renewable Materials | Daylight & Views |
|---|---|---|---|---|---|
| ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |

Location Dependent

**LEED for Schools**

| Acoustics | Low Emitting or CHPS |
|---|---|
| ✔ | ✔ |

$$$$$

## Visual Selection

## Performance Selection

Dots represent highest level of performance.

| Edge Profile | Item No. | Dimensions | | UL Classified Acoustics NRC | CAC | Fire Rating | Light Reflect | Sag Resist | Anti-Microbial | VOC Formaldehyde | Durable: Wash | Impact | Scratch | Soil | Recycle Program |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ULTIMA† Tegular** | | | | | | | | | | | | | | | |
| 9/16" Beveled Tegular | **1916**<br>**1916M** | 1' x 2' x 3/4"<br>300 x 600 x 19mm | ▭ | N/A | N/A | Class A | 0.90<br>● | HumiGuard+<br>● | BioBlock+<br>● | No Added | Wash<br>● | Impact<br>● | Scratch<br>● | Soil<br>● | Yes<br>● |
| | **1912**<br>**1912M**<br>**1912HRC*** | 2' x 2' x 3/4"<br>600 x 600 x 19mm<br>2' x 2' x 3/4" | □ | 0.70<br>● | 35◆ | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | NEW **1952**<br>**1952M** | 2' x 2' x 3/4"<br>600 x 600 x 19mm | □ | 0.60 | 40<br>● | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | **1915**<br>**1915M**<br>**1915HRC*** | 2' x 4' x 3/4"<br>600 x 1200 x 19mm<br>2' x 4' x 3/4" | ▭ | 0.70<br>● | 35 | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | **1905**<br>**1905M** | 30" x 30" x 3/4"<br>750 x 750 x 19mm | □ | 0.70<br>● | 35 | Class A | 0.90<br>● | S | ● | No Added | ● | ● | ● | ● | ● |
| 15/16" Beveled Tegular | **1917**<br>**1917M** | 1' x 2' x 3/4"<br>300 x 600 x 19mm | ▭ | N/A | N/A | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | **1911**<br>**1911M**<br>**1911HRC*** | 2' x 2' x 3/4"<br>600 x 600 x 19mm<br>2' x 2' x 3/4" | □ | 0.70<br>● | 35 | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | NEW **1951**<br>**1951M** | 2' x 2' x 3/4"<br>600 x 600 x 19mm | □ | 0.60 | 40<br>● | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |
| | **1914**<br>**1914M**<br>**1914HRC*** | 2' x 4' x 3/4"<br>600 x 1200 x 19mm<br>2' x 4' x 3/4" | ▭ | 0.70<br>● | 35 | Class A | 0.90<br>● | ● | ● | No Added | ● | ● | ● | ● | ● |

S = Standard
† US Patent 5,674,594
◆ 1912-CAC 33 on 9/16" Interlude, Sonata, Suprafine
* The recycled content of this product is: 65% pre-consumer; 15% post-consumer

### Suspension Systems

| | |
|---|---|
| 9/16" | Standard: Interlude®, Silhouette® Bolt-Slot, Sonata™, Suprafine®, Trimlok® Screw-Slot |
| 15/16" | Standard: Prelude® |

## Physical Data

**Material**
Wet-formed mineral fiber with DuraBrite® acoustically transparent membrane

**Surface Finish**
DuraBrite with factory-applied acrylic latex paint

**Fire Performance**
ASTM E84 and CAN/ULC S102 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less. (UL labeled)

**ASTM E1264 Classification**
Type IV, Form 2, Pattern E
Fire Class A

**Sag Resistance**
HumiGuard® Plus – superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications.

**No-Added Formaldehyde**
No-added formaldehyde – free of formaldehyde-based resins. Outperforms CHPS Section 01350 requirements. (Independent test reports available upon request.)

**Anti-Mold/Mildew & Bacteria**
BioBlock® Plus contains an anti-microbial treatment and provides guaranteed resistance against growth of mold/mildew and Gram-positive and Gram-negative odor/stain-causing bacteria for 30 years.

**Insulation Value**
R Factor – 2.2 (BTU units)
R Factor – 0.39 (Watts units)

**Backloading Recommendation**
Contact TechLine for specific information

**30-Year Performance Guarantee & Warranty Information**
See warranty details at armstrong.com/warranty

**Application Considerations**
1′ x 2′ products are not intended for a full ceiling installation and are not UL Classified for acoustics.

**Weight; Square Feet/Carton**
1905 – 1.05 lbs/SF; 62.5 SF/ctn
1911, 1912, 1914, 1915 – 1.05 lbs/SF; 48 SF/ctn
1916, 1917 – 1.05 lbs/SF; 24 SF/ctn
1951, 1952 – 1.31 lbs/SF; 48 SF/ctn

**TechLine℠** / 1 877 ARMSTRONG
1 877 276 7876
**armstrong.com/ceilings (search: ultima)**
CS-3039-309



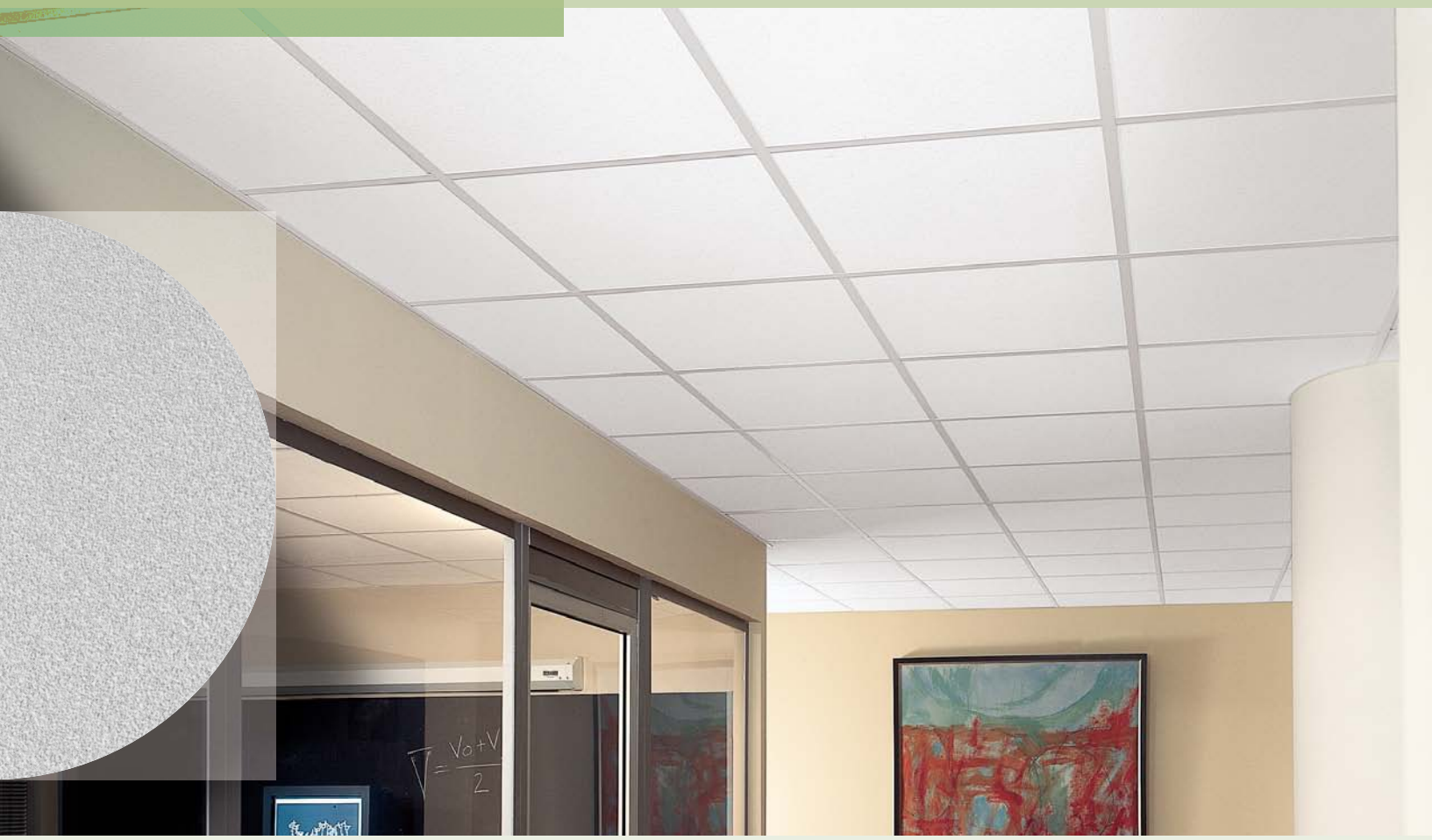
Armstrong

# ULTIMA®

## Square Lay-in

fine texture

10-YEAR Availability Items 1910, 1913



Ultima Square Lay-in with Prelude® 15/16" Exposed Tee grid

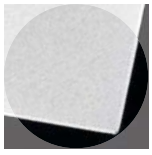
### Key Selection Attributes

- Smooth, clean, durable finish –
  - Washable
  - Impact-resistant
  - Scratch-resistant
  - Soil-resistant
- Excellent sound absorption
- 30-Year Limited System Warranty against visible sag, mold/mildew and bacterial growth
- Visual coordinates with OPTIMA® for mixed (open/closed plan) applications
- Non-directional visual reduces installation time and scrap
- Compatible with the TECHZONE™ Ceiling Systems
- Smaller size panels available (1 carton min. order). Info: armstrong.com/specials

### Typical Applications

- Offices
- Healthcare – assists in addressing HIPAA requirements
- Classrooms
- Corridors
- Lobbies/reception areas
- Department stores/retail

### Detail



ULTIMA
Square Lay-in

ULTIMA Square Lay-in
with PRELUDE 15/16"
Exposed Tee Grid

### Color

White (WH)

Armstrong®

# ULTIMA®

## Square Lay-in

fine texture

**Recycled Content:** 70-80%

**LEED® Credits**

| Energy | Waste Mgmt | Recycled Content | Local Materials | Renewable Materials | Daylight & Views |
|---|---|---|---|---|---|
| ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| | | | Location Dependent | | |

**LEED for Schools**

| Acoustics | Low Emitting or CHPS |
|---|---|
| ✔ | ✔ |

$$$$$

## Visual Selection

## Performance Selection

Dots represent highest level of performance.

| Edge Profile | Item No. | Dimensions | | UL Classified Acoustics NRC | CAC | Fire Rating | Light Reflect | Sag Resist | Anti-Microbial | VOC Formal-dehyde | Durable: Wash | Impact | Scratch | Soil | Recycle Program |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ULTIMA†** | | | | | | | | | | | | | | | |
| 15/16" Square Lay-in | **1910**<br>**1910M** | 2' x 2' x 3/4"<br>600 x 600 x 19mm | □ | 0.70<br>• | 35 | Class A | 0.90<br>• | HumiGuard+<br>• | BioBlock+<br>• | No Added | Wash<br>• | Impact<br>• | Scratch<br>• | Soil<br>• | Yes<br>• |
| | **1913**<br>**1913M** | 2' x 4' x 3/4"<br>600 x 1200 x 19mm | ▭ | 0.70<br>• | 35 | Class A | 0.90<br>• | • | • | No Added | • | • | • | • | • |

† US Patent 5,674,594

### Suspension Systems

| | |
|---|---|
| 15/16" | Standard: Prelude® |

## Physical Data

**Material**
Wet-formed mineral fiber with DuraBrite® acoustically transparent membrane

**Surface Finish**
DuraBrite with factory-applied acrylic latex paint

**Fire Performance**
ASTM E84 and CAN/ULC S102 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less. (UL labeled)

**ASTM E1264 Classification**
Type IV, Form 2, Pattern E
Fire Class A

**Sag Resistance**
HumiGuard® Plus – superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications.

**No-Added Formaldehyde**
No-added formaldehyde – free of formaldehyde-based resins. Outperform CHPS Section 01350 requirements. (Independent test reports available upon request.)

**Anti Mold/Mildew & Bacteria**
BioBlock® Plus contains an anti-microbial treatment and provides guaranteed resistance against growth of mold/mildew and Gram-positive and Gram-negative odor/stain-causing bacteria for 30 years.

**Insulation Value**
R Factor – 2.2 (BTU units)
R Factor – 0.39 (Watts units)

**Backloading Recommendation**
Contact TechLine for specific information

**30-Year Performance Guarantee & Warranty Information**
See warranty details at armstrong.com/warranty

**Weight; Square Feet/Carton**
1.08 lbs/SF; 48 SF/ctn

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1 877 276 7876
**armstrong.com/ceilings (search: ultima)**
CS-3694-109



Armstrong®

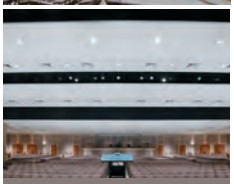
# OPTIMA®

**Square Lay-in**
fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

10-YEAR Availability Items 3152 & 3153

Optima Square Lay-in with Prelude® 15/16" suspension system (Pg. 259)



Visit Armstrong.com Photo Gallery to view more installation photos

SEARCH: optima

## KEY SELECTION ATTRIBUTES

- Outstanding acoustical performance for open plan areas, both Articulation Class (180-200) and NRC (0.90-1.00)
- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Energy-saving high light-reflective finish
- Non-directional visual reduces installation time and scrap
- Items with PB suffix are manufactured with a plant-based binder
- Sag-resistant large size panels
- Compatible with TechZone™ Ceiling Systems (Pgs. 233-239)
- Item 3352 available with Create!™ colors and images, see pages 165-167
- 30-Year Limited System Warranty against visible sag, mold/mildew, and bacterial growth

## TYPICAL APPLICATIONS

- Open plan offices
- Computer rooms
- Corridors (walls-to-deck)
- Auditoriums
- Waiting rooms/nurses' stations – assists in addressing HIPAA and FGI acoustical requirements
- Areas with indirect lighting systems

## DETAIL (Other Suspension Systems compatible. Refer to listing on page 196.)



1. Optima Square Lay-in
2. Optima Square Lay-in with Prelude 15/16" suspension system

## COLOR

White

Create! colors available on item 3352. See pages 165-167.

FIBERGLASS

# OPTIMA®

## Square Lay-in

fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

UP TO 71% RECYCLED CONTENT

EPD AVAILABLE

LEED® acoustics energy daylight & views indoor air quality renewable materials recycled content waste mgmt local* materials

Calculate LEED contribution at armstrong.com/greengenie *LOCATION DEPENDENT

### VISUAL SELECTION

### PERFORMANCE Dots represent high level of performance.

| Edge Profile | Susp. Dwg. Pgs. 273-277 armstrong.com/catdwgs | Item No. | Dimensions (Inches) | Acoustics NRC | Acoustics CAC | Acoustics AC | Fire Rating | Light Reflect | Anti-Mold & Mildew | Sag Resist | Cerified Low VOC Emissions | Durability Wash | Durability Impact | Durability Scratch | Durability Soil | Primary (Embodied) Energy | Recycle Content◆ | Recycle Program | Warranty† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OPTIMA Square Lay-in** | | | | UL Classified | | | | | Inherent | Humi-Guard+ | | | | | | Below 11MJ/SF | | Yes | No. of Years |
| 15/16" Square Lay-in | 1 | **1400** | 6 x 48 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **1404** | 6 x 60 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3156** | 20 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3150** **3150PB** | 24 x 24 x 3/4" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3152** **3152PB** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3352** | 24 x 24 x 1" | 0.90 ● | 26 | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | – | 30 |
| | 1 | **3159** | 24 x 24 x 1-1/2" | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3151** **3151PB** | 24 x 48 x 3/4" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3153** **3153PB** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3353** | 24 x 48 x 1" | 0.90 ● | 26 | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | – | 30 |
| | 1 | **3155** | 24 x 48 x 1-1/2" | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3356** | 24 x 48 x 1-1/2" | 0.95 ● | 26 | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | – | 30 |
| | 1 | **3164** | 24 x 60 x 3/4" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3161** | 24 x 72 x 3/4" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3162** | 24 x 96 x 3/4" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3158** | 30 x 30 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3157** | 30 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3160** **3160PB** | 48 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **3154** | 48 x 96 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **Other Sizes** | W: 4" - 24" / L: 4" - 96" 3/4" Thick | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | NEW **FastSize**™ | W: 4" - 48" / L: 4" - 120" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1 | **Other Sizes** | W: 4" - 42" / L: 4" - 120" W: 4" - 48" / L: 4" - 114" 1-1/2" Thick | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |

FIBERGLASS

# OPTIMA®

## Square Lay-in

fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

UP TO 71% RECYCLED CONTENT

EPD AVAILABLE

LEED® acoustics energy daylight & views indoor air quality renewable materials recycled content waste mgmt local* materials

Calculate LEED contribution at armstrong.com/greengenie *LOCATION DEPENDENT

## VISUAL SELECTION

## PERFORMANCE

Dots represent high level of performance.

| Edge Profile | Susp. Dwg. Pgs. 273-277 armstrong.com/catdwgs | Item No. | Dimensions (Inches) | Acoustics NRC | Acoustics CAC | Acoustics AC | Fire Rating | Light Reflect | Anti-Mold & Mildew | Sag Resist | Cerified Low VOC Emissions | Durability | | | | | Primary (Embodied) Energy | Recycle Content◆ | Recycle Program | Warranty† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | UL Classified | | | | | Inherent | Humi-Guard+ | | Water Repel | Wash | Impact | Scratch | Soil | | | | No of Years |
| **OPTIMA Square Lay-in** | | | | | | | | | | | | | | | | | | | | |
| 9/16" Square Lay-in | 23 | **1401** | 6 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 23 | **1405** | 6 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | – | ● | ● | ● | ● | ● | High | ● | 30 |
| **OPTIMA Health Zone™ Square Lay-in** | | | | | | | | | | | | | | | | | | | | |
| 15/16" Square Lay-in | 1, 6, 7 | **3114** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1, 6, 7 | **3314** | 24 x 24 x 1-1/2" | 0.95 ● | 29** | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | High | – | 30 |
| | 1, 6, 7 | **3115** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 1, 6, 7 | **3315** | 24 x 48 x 1-1/2" | 0.95 ● | 29** | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | High | – | 30 |
| | 1, 6, 7 | **Other Sizes** | W: 4" - 48" / L: 12" - 48" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | High | ● | 30 |

** CAC 29 achieved with Clean Room™ suspension system, not UL classified for acoustics.

## SUSPENSION SYSTEMS

1-1/2"

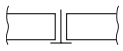
Clean Room (Aluminum)

15/16"

Prelude®

Clean Room (Steel and Aluminum)

9/16"



Suprafine®

## PHYSICAL DATA

**Material**
3115, 3150-3153, 3155, 3156, 3158, 3159 – Fiberglass with DuraBrite® acoustically transparent membrane
3352, 3353, 3356, 3314, 3315 – Fiberglass with DuraBrite acoustically transparent membrane;
CAC backing

**Surface Finish**
DuraBrite with factory-applied latex paint

**Fire Performance**
ASTM E84 and CAN/ULC S102 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less. (UL labeled)

**ASTM E1264 Classification**
Type XII, Form 2, Pattern E
Fire Class A

**Sag Resistance**
HumiGuard® Plus – superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications.

**Anti Mold/Mildew & Bacteria**
Fiberglass substrate is inherently resistant to the growth of mold, mildew, and bacteria.

**VOC Emissions (PB suffix items only)**
Third party certified compliant with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010. This standard is the guideline for low emissions in LEED, CalGreen Title 24, ANSI/ASHRAE/USGBC/IES Standard 189; ANSI/GBI Green Building Assessment Protocol.

**Primary (Embodied) Energy**
See all LCA information on our EPD's.

**High Recycled Content◆**
Contains greater than 50% total recycled content. Total recycled content based on product composition of post-consumer and pre-consumer (post-industrial) recycled content per FTC guidelines.

**Acoustical Details**
Some items have CAC backing. CAC backing may be available as a special order. A CAC value of 37 can be achieved by backloading fiberglass products with item 769 or 770.

**Insulation Value**
1400, 1401, 1404, 1405, 3114, 3115, 3152, 3153, 3156, 3158, 3352, 3353, 3154, 3160, 3157 –
R Factor – 4.0 (BTU units)
R Factor – 0.70 (Watts units)
3150, 3151, 3161, 3162, 3164 –
R Factor – 3.0 (BTU units)
R Factor – 0.53 (Watts units)
3155, 3159, 3356, 3314, 3315 –
R Factor – 6.0 (BTU units)
R Factor – 1.05 (Watts units)

**Application Consideration**
Do not mix Optima and Optima Health Zone in the same room.

**30-Year Performance Guarantee & Warranty†**
When installed with Armstrong Suspension System. Details at armstrong.com/warranty

**Weight; Square Feet/Carton**
3150, 3151 – 0.44 lbs/SF; 128 SF/ctn
3152, 3153, 3114, 3115 – 0.45 lbs/SF; 96 SF/ctn
3155, 3159, 3356 – 0.61 lbs/SF; 64 SF/ctn
3156 – 0.47 lbs/SF; 100 SF/ctn
3158 – 0.47 lbs/SF; 75 SF/ctn
3352, 3353 – 0.46 lbs/SF; 96 SF/ctn
3154, 3160 – 0.45 lbs/SF; 128 SF/ctn
3157 – 0.56 lbs/SF; 100 SF/ctn
3161 – 0.43 lbs/SF; 96 SF/ctn
3164 – 0.43 lbs/SF; 100 SF/ctn
3162 – 0.42 lbs/SF; 128 SF/ctn
1400,1401 – 0.13 lbs/SF; 24 SF/ctn
1404, 1405 – 0.16 lbs/SF; 30 SF/ctn
3314, 3315 – 0.45 lbs/SF; 96 SF/ctn

**Minimum Order Quantity**
1 carton

**Metric Items Available**
3150M, 3151M, 3152M, 3153M, 3154M, 3155M, 3156M, 3158M, 3159M, 3160M, 3353M, 3356M – Metric items are subject to extended lead times and minimum quantities. Contact your representative for more details.

# OPTIMA®

**Tegular**
fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

Optima Tegular 24" x 24" panels with Sonata® 9/16" suspension system (Pg. 265)

Visit Armstrong.com Photo Gallery to view more installation photos

SEARCH: optima

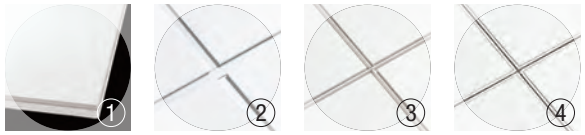
## KEY SELECTION ATTRIBUTES

- Outstanding acoustical performance for open plan areas, both Articulation Class (180-200) and NRC (0.90-1.00)
- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Energy-saving high light-reflective finish
- Non-directional visual reduces installation time and scrap
- Items with PB suffix are manufactured with a plant-based binder
- Sag-resistant large size panels
- Compatible with TechZone™ Ceiling Systems (Pgs. 235-241)
- 30-Year Limited System Warranty against visible sag, mold/mildew, and bacterial growth

## TYPICAL APPLICATIONS

- Open plan offices
- Computer rooms
- Corridors (walls-to-deck)
- Auditoriums
- Waiting rooms/nurses' stations – assists in addressing HIPAA and FGI acoustical requirements
- Areas with indirect lighting systems

## DETAIL (Other Suspension Systems compatible. Refer to listing on page 200.)




1. Optima Square Tegular
2. Optima Tegular with Prelude® 15/16" suspension system
3. Optima Tegular with Interlude® XL® 9/16" suspension system
4. Optima Tegular with Silhouette® 9/16" suspension system with 1/8" reveal

## COLOR

White

# OPTIMA®

**Tegular**
fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

UP TO 71% RECYCLED CONTENT

EPD AVAILABLE

LEED® acoustics energy daylight & views indoor air quality renewable materials recycled content waste mgmt local* materials

Calculate LEED contribution at armstrong.com/greengenie *LOCATION DEPENDENT

$$$$

## VISUAL SELECTION

## PERFORMANCE

Dots represent high level of performance.

| Edge Profile | Susp. Dwg. Pgs. 273-277 armstrong.com/catdwgs | Item No. | Dimensions (Inches) | Acoustics NRC | Acoustics CAC | Acoustics AC | Fire Rating | Light Reflect | Anti-Mold & Mildew | Sag Resist | Certified Low VOC Emissions | Durability Wash | Durability Impact | Durability Scratch | Durability Soil | Primary (Embodied) Energy | Recycled Content◆ | Recycle Program | Warranty† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OPTIMA Tegular** | | | | UL Classified | | | | | Inherent | Humi-Guard+ | | | | | | Below 11MJ/SF | | Yes | No. of Years |
| 15/16" Square Tegular | 8 | **1402** | 6 x 48 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **1406** | 6 x 60 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3264** | 12 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3278** | 20 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3250 3250PB** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3354** | 24 x 24 x 1" | 0.90 ● | 26 | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | – | 30 |
| | 8 | **3253** | 24 x 24 x 1-1/2" | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3252 3252PB** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3281** | 24 x 72 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3282** | 24 x 96 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3258** | 30 x 30 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3286** | 30 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 | **3255 3255PB** | 48 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8 NEW | **FastSize**™ | W: 4" - 48" / L: 4" - 120" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | – | High | ● | 30 |
| | 8 | **Other Sizes** | W: 4" - 36" / L: 4" - 120"<br>W: 4" - 42" / L: 4" - 102"<br>W: 4" - 48" / L: 4" - 90"<br>1-1/2" Thick | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | – | High | ● | 30 |
| 9/16" Square Tegular | 26, 43, 47, 51, 55, 59 | **1410** | 4 x 48 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1411** | 4 x 60 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1412** | 6 x 6 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1413** | 6 x 12 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1415** | 6 x 42 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1403** | 6 x 48 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1417** | 6 x 54 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1407** | 6 x 60 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1409** | 6 x 96 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3263** | 12 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3290** | 12 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **1414** | 12 x 96 x 1" | 0.90 ● | N/A | 180 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3276** | 20 x 54 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3266** | 20 x 56 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |

FIBERGLASS

# OPTIMA®

**Tegular**
fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

UP TO 71% RECYCLED CONTENT

EPD AVAILABLE

LEED® acoustics ✓ energy ✓ daylight & views ✓ indoor air quality ○ renewable materials ○ recycled content ✓ waste mgmt ✓ local* materials ✓

Calculate LEED contribution at armstrong.com/greengenie *LOCATION DEPENDENT

## VISUAL SELECTION

## PERFORMANCE

Dots represent high level of performance.

| Edge Profile | Susp. Dwg. Pgs. 273-277 armstrong.com/catdwgs | Item No. | Dimensions (Inches) | Acoustics NRC | Acoustics CAC | Acoustics AC | Fire Rating | Light Reflect | Anti-Mold & Mildew | Sag Resist | Certified Low VOC Emissions | Durability: Wash | Durability: Impact | Durability: Scratch | Durability: Soil | Primary (Embodied) Energy | Recycled Content◆ | Recycle Program | Warranty† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OPTIMA Tegular** | | | | UL Classified | | | | | Inherent | Humi-Guard+ | | | | | | Below 11MJ/SF | | Yes | No. of Years |
| 9/16" Square Tegular | 26, 43, 47, 51, 55, 59 | **3277** | 20 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3279** | 21 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3251** **3251PB** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3355** | 24 x 24 x 1" | 0.90 ● | 26 | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | – | 30 |
| | 26, 43, 47, 51, 55, 59 | **3254** | 24 x 24 x 1-1/2" | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3280** | 24 x 42 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3257** **3257PB** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3265** **3265PB** | 24 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3261** **3261PB** | 24 x 72 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3262** **3262PB** | 24 x 96 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3283** | 27 x 30 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3268** | 28 x 30 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3269** | 28 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3259** | 30 x 30 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3284** | 30 x 54 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3289** | 30 x 56 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3285** | 30 x 60 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3287** | 42 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3288** | 44 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3256** **3256PB** | 48 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3249** | 48 x 54 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | NEW **FastSize™** | W: 4" - 48" / L: 4" - 120" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **Other Sizes** | W: 4" - 36" / L: 4" - 120"<br>W: 4" - 42" / L: 4" - 102"<br>W: 4" - 48" / L: 4" - 90"<br>1-1/2" Thick | 1.00 ● | N/A | 200 ● | Class A | 0.90 ● | ● | ● | – | ● | ● | ● | ● | ● | High | ● | 30 |

# OPTIMA®

**Tegular**
fine texture

Items with Breakthrough Plant-based Binder have a PB Suffix

UP TO 71% RECYCLED CONTENT

EPD AVAILABLE

LEED® acoustics, energy, daylight & views, indoor air quality, renewable materials, recycled content, waste mgmt, local* materials

Calculate LEED contribution at armstrong.com/greengenie *LOCATION DEPENDENT

## VISUAL SELECTION

## PERFORMANCE Dots represent high level of performance.

| Edge Profile | Susp. Dwg. Pgs. 273-277 armstrong.com/catdwgs | Item No. | Dimensions (Inches) | Acoustics NRC | Acoustics CAC | Acoustics AC | Fire Rating | Light Reflect | Anti-Mold & Mildew | Sag Resist | Certified Low VOC Emissions | Durability: Water Repel | Durability: Wash | Durability: Scrub | Durability: Impact | Durability: Scratch | Durability: Soil | Primary (Embodied) Energy | Recycled Content◆ | Recycle Program | Warranty† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OPTIMA Health Zone™** | | | | UL Classified | | | | | Inherent | Humi-Guard+ | | | | | | | | Below 11MJ/SF | | Yes | No. of Years |
| 15/16" Square Tegular | 8, 10 | **3214** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8, 10 | **3316** | 24 x 24 x 1-1/2" | 0.95 ● | 29** | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | – | 30 |
| | 8, 10 | **3215** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 8, 10 | **3317** | 24 x 48 x 1-1/2" | 0.95 ● | 29** | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | – | 30 |
| | 8, 10 | **Other Sizes** | W: 4" - 48" / L: 12" - 48" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| 9/16" Square Tegular | 26, 43, 47, 51, 55, 59 | **3216** | 24 x 24 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **3217** | 24 x 48 x 1" | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |
| | 26, 43, 47, 51, 55, 59 | **Other Sizes** | W: 4" - 48" / L: 12" - 48" 1" Thick | 0.95 ● | N/A | 190 ● | Class A | 0.86 ● | ● | ● | – | ● | ● | ● | ● | ● | ● | ● | High | ● | 30 |

** CAC 29 achieved with Clean Room™ suspension system, not UL classified for acoustics.

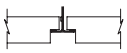
## SUSPENSION SYSTEMS

15/16"

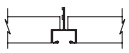
Prelude®

Clean Room (Steel or Aluminum)

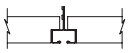
9/16"



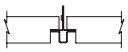
Suprafine®



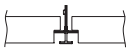
Silhouette® 1/4" Reveal



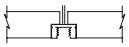
Silhouette 1/8" Reveal



Interlude®



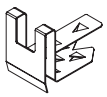
Sonata®



Trimlok®

## ACCESSORIES (not included; ordered separately)

**435**



Stabilizer Clip (3/4" & 1")

Recommended for panels 60" and greater in length

**Note:** Panels 60" up to 96" – One clip near mid-point of each long edge.
Panels 96" and over – Two clips at 1/3 points of each long edge.

**7870**

Spring Border Clip

(For installations with the panel resting on the wall molding)

## PHYSICAL DATA

**Material**
3316, 3317, 3354, 3355 – Fiberglass with DuraBrite® acoustically transparent membrane; CAC backing
All other items – Fiberglass with DuraBrite acoustically transparent membrane

**Surface Finish**
DuraBrite with factory-applied latex paint

**Fire Performance**
ASTM E84 and CAN/ULC S102 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less. (UL labeled)

**ASTM E1264 Classification**
Type XII, Form 2, Pattern E
Fire Class A

**Sag Resistance**
HumiGuard® Plus – superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications.

**Anti Mold/Mildew & Bacteria**
Fiberglass substrate is inherently resistant to the growth of mold, mildew, and bacteria.

**VOC Emissions (PB items only)**
Third party certified compliant with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010. This standard is the guideline for low emissions in LEED, CalGreen Title 24, ANSI/ASHRAE/USGBC/IES Standard 189; ANSI/GBI Green Building Assessment Protocol.

**Primary (Embodied) Energy**
See all LCA information on our EPD's.

**High Recycled Content◆**
Contains greater than 50% total recycled content. Total recycled content based on product composition of post-consumer and pre-consumer (post-industrial) recycled content per FTC guidelines.

**Acoustical Details**
Some items have CAC backing. CAC backing may be available as a special order. A CAC value of 37 can be achieved by backloading fiberglass products with Item 769 or 770.

**Insulation Value**
3253, 3254 –
R Factor – 6.0 (BTU units)
R Factor – 1.05 (Watts units)
3281, 3282 –
R Factor – 3.0 (BTU units)
R Factor – 0.53 (Watts units)
All other items –
R Factor – 4.0 (BTU units)
R Factor – 0.70 (Watts units)

**30-Year Performance Guarantee & Warranty†**
When installed with Armstrong Suspension System. Details at armstrong.com/warranty

**Weight; Square Feet/Carton**
1402, 1403 – 0.55 lbs/SF; 24 SF/ctn
1406, 1407 – 0.55 lbs/SF; 30 SF/ctn
1409, 3249, 3250, 3250PB, 3251, 3251PB, 3252, 3252PB, 3257, 3262, 3262PB, 3282 – 0.55 lbs/SF; 96 SF/ctn
1410 – 0.55 lbs/SF; 16 SF/ctn
1411 – 0.55 lbs/SF; 20 SF/ctn
1412 – 0.55 lbs/SF; 6 SF/ctn
1413 – 0.55 lbs/SF; 12 SF/ctn
1414, 3263, 3264, 3290 – 0.55 lbs/SF; 48 SF/ctn
1415 – 0.55 lbs/SF; 21 SF/ctn
1417 – 0.55 lbs/SF; 27 SF/ctn
3214 – 0.45 lbs/SF; 128 SF/ctn
3215, 3216, 3217 – 0.45 lbs/SF; 96 SF/ctn
3253, 3254 – 0.78 lbs/SF; 64 SF/ctn
3255, 3255PB, 3256, 3256PB – 0.55 lbs/SF; 128 SF/ctn
3258, 3259, 3276 – 0.55 lbs/SF; 75 SF/ctn
3261 – 0.55 lbs/SF; 72 SF/ctn
3265PB, 3277, 3278, 3285, 3286 – 0.55 lbs/SF; 100 SF/ctn
3266 – 0.55 lbs/SF; 62.22 SF/ctn
3268 – 0.55 lbs/SF; 70 SF/ctn
3269 – 0.55 lbs/SF; 93.33 SF/ctn
3279, 3280 – 0.55 lbs/SF; 84 SF/ctn
3281 – 0.55 lbs/SF; 72 SF/ctn
3283 – 0.55 lbs/SF; 67.5 SF/ctn
3284 – 0.55 lbs/SF; 90 SF/ctn
3287 – 0.55 lbs/SF; 112 SF/ctn
3288 – 0.55 lbs/SF; 117.33 SF/ctn
3316, 3317 – 0.75 lbs/SF; 64 SF/ctn
3354, 3355 – 0.57 lbs/SF; 96 SF/ctn

**Minimum Order Quantity**
1 carton

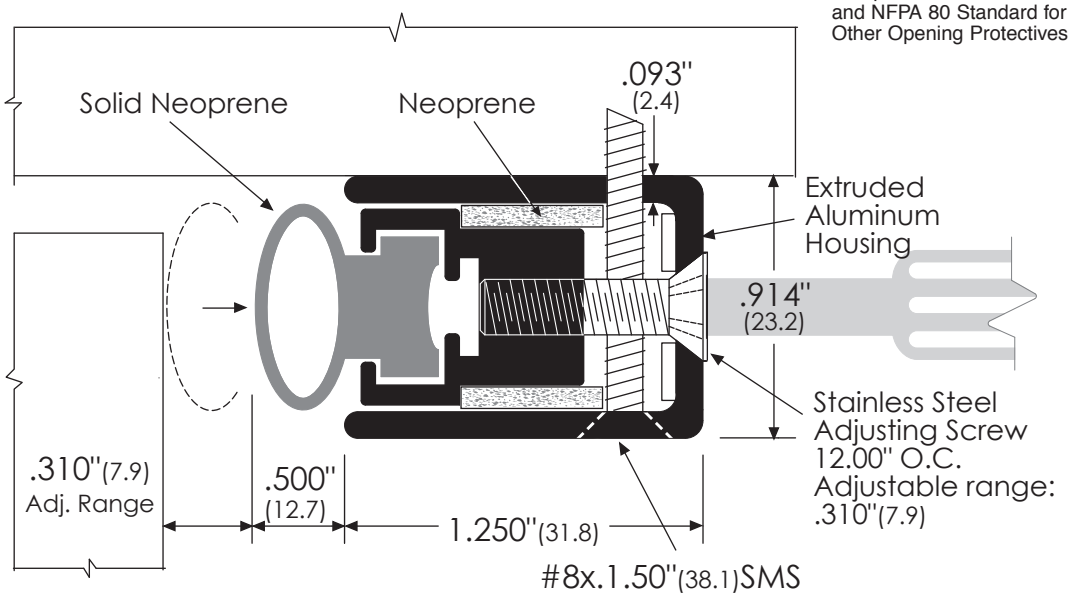
**Metric Items Available**
3250M, 3251M, 3252M, 3253M, 3254M, 3256M, 3257M, 3354M, 3355M – Metric items are subject to extended lead times and minimum quantities. Contact your representative for more details.

## FIRE RATING

- UL listed
- 10B Classified up to 45 minutes
- 10C Classified
- Category G Listed up to 20 minutes

## SMOKE PERFORMANCE

The rubber seal in this gasket provides protection from smoke infiltration in accordance with provisions of NFPA 101 Life Safety Code and NFPA 80 Standard for Fire Doors and Other Opening Protectives





ZERO INTERNATIONAL

415 Concord Avenue
Bronx, NY 10455
tel: 718.585.3230
fax: 718.292.2243
email: zero@zerointernational.com
web site: www.zerointernational.com


**Part No:** 770

**Notes:**

**Part Description:**

Adjustable Sealing System

- STC Rated

| Provided By: | Customer Name: | Job No: | Date: |
|---|---|---|---|
| | | | |

## FIRE RATING

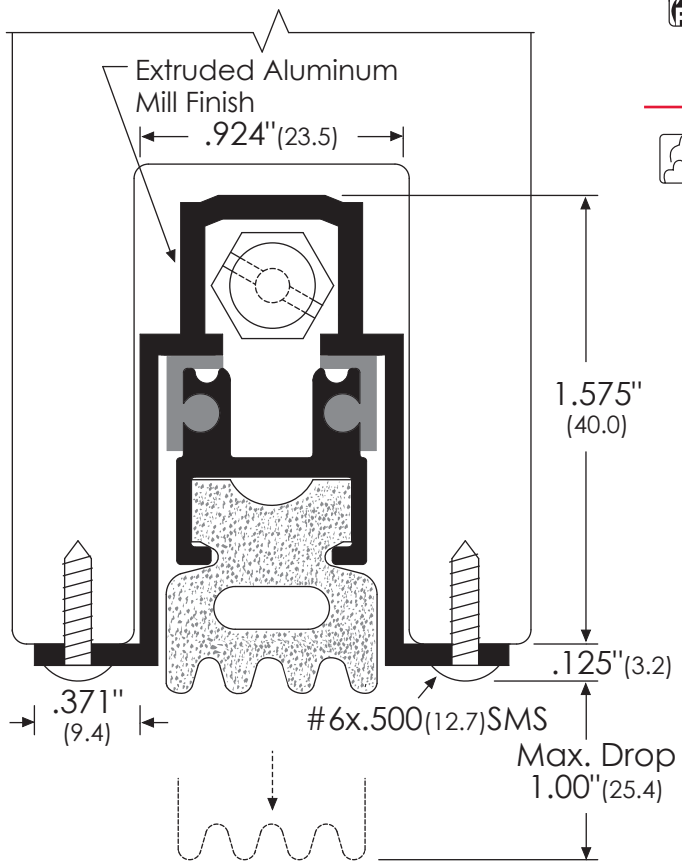
UL listed

ITS Warnock Hersey listed

10C Classified

## SMOKE PERFORMANCE

The rubber seal in this gasket provides protection from smoke infiltration in accordance with provisions of NFPA 101 Life Safety Code and NFPA 80 Standard for Fire Doors and Other Opening Protectives




**Legend:**
A = Aluminum

## ANSI/BHMA

| | |
|---|---|
| #360A | R3C324 |


415 Concord Avenue
Bronx, NY 10455
tel: 718.585.3230
fax: 718.292.2243
email: zero@zerointernational.com
web site: www.zerointernational.com


**Part No:** 360

**Notes:**

**Part Description:**

Automatic Door Bottom

- Mortised / Heavy Duty

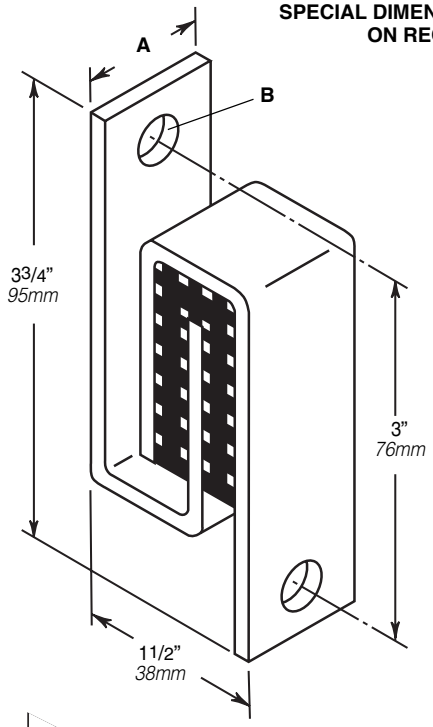
| Provided By: | Customer Name: | Job No: | Date: |
|---|---|---|---|
| | | | |

**MASON INDUSTRIES, Inc.**
*Manufacturers of Vibration Control Products*
350 Rabro Drive, Hauppauge, NY 11788, 631/348-0282, FAX 631/348-0279, Info@Mason-Ind.com, www.Mason-Ind.com
2101 W. Crescent Ave., Suite D, Anaheim, CA 92801, 714/535-2727, FAX 714/535-5738, Info@MasonAnaheim.com, www.MasonAnaheim.com

**CERTIFIED FOR**
**JOB NAME** _____
**CUSTOMER** _____
**CUSTOMER P.O.** _____
**MASON M.I.** _____ **DWG No.** _____

**TYPE**
# WIC
**SWAY BRACE**

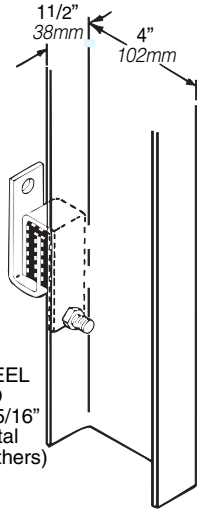
**SPECIAL DIMENSIONS ON REQUEST**




**COMMON WALL WEIGHTS**

| Thickness (in)(*mm*) | Material | (lbs/ft²) (*kg/m²*) |
|---|---|---|
| 4 *102* | Brick | 35 *175* |
| 8 *203* | | 75 *365* |
| 12 *305* | | 115 *560* |
| 4 *102* | Heavy Aggregate Hollow Concrete Block | 35 *175* |
| 6 *152* | | 50 *245* |
| 8 *203* | | 58 *285* |
| 12 *305* | | 90 *440* |
| 4 *102* | Poured Concrete Masonry | 48 *235* |
| 6 *152* | | 72 *350* |
| 8 *203* | | 96 *470* |
| 12 *305* | | 144 *705* |

| Thickness (in)(*mm*) | Material | (lbs/ft²) (*kg/m²*) |
|---|---|---|
| 4 *102* | Steel Studding Alone | 1.5 *7.5* |
| 2x4 *51x102* | Wood Studding Alone | 2.0 *10* |
| 1/2 *13* | Gypsum Board | 2.1 *10* |
| 5/8 *16* | | 2.7 *13* |
| 3/4 *19* | | 3.2 *16* |
| 1 *25* | Cement Plaster | 10.0 *50* |
| 1 *25* | Gypsum Plaster | 5.0 *25* |
| - | Metal Lathe | 0.5 *2.5* |
| - | Gypsum Lathing Board | 2.0 *10* |



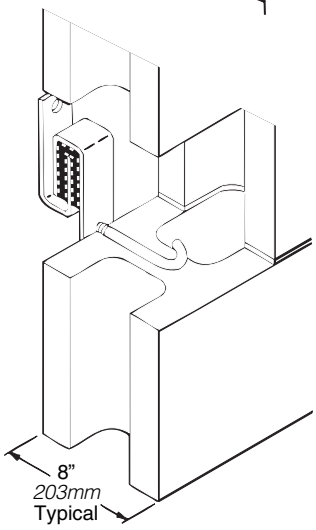

STANDARD STEEL STUDDING END
WIC Brace with 5/16" *8mm* Bolt for Metal Studs (Bolt by Others)

**MATERIAL:**

**Standard 40 Durometer 5/16"(*8mm*) Neoprene Waffle Pad**

**TYPE WIC DIMENSIONS (in *mm*)**

| Type & Size | A | B Hole Diameter |
|---|---|---|
| WIC-1 | 1 *25* | 3/8 *10* |
| WIC-2 | 2 *51* | 3/8 *10* |




STANDARD CONCRETE BLOCK END
WIC Brace with 5/16" *8mm* Diameter Rod with 2" *51mm* I.D. Hooked End for Masonry Walls (Hook by Others)

**TYPE WIC LOAD RATINGS**

| Type & Size | Rated Horizontal Restraint & Deflection if Stressed: Load (lb)(*kg*) | Defl (in)(*mm*) | Maximum Assigned Wall Weight (lb)(*kg*) | Minimum Assigned Weight to Establish 15Hz(lb)(*kg*) |
|---|---|---|---|---|
| WIC-1 | 90 *41* | 0.05 *1.3* | 250 *113* | 50 *23* |
| WIC-2 | 260 *118* | 0.05 *1.3* | 500 *227* | 100 *45* |

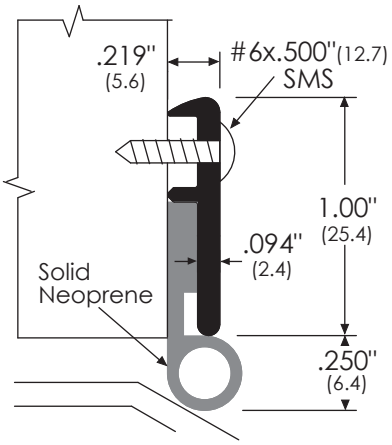
1. Sway braces prevent buckling or overturning of tall or long walls.
2. Buckling forces are extremely small when braces are reasonably spaced both horizontally and vertically as the brace spacing maintains a very low l/r column ratio.
3. Our general recommendation is spacing on four foot centers both horizontally and vertically.
4. The maximum axial restraint rating is approximately 33% of the maximum assigned wall weight and extremely conservative.
5. Vertical resistance information is provided for checking embedment requirements in walls and shear or pullout forces on both ends of the sway braces. Sway braces are not to be used for vertical supports.
6. Response frequency is a function of the attached mass and the dynamic stiffness in the direction of vibration. The 15 Hz response is normally lower and more desirable than what is usually specified. Heavier weight assignments than the specified minimum will lower the response frequency by the square root of the ratio of the minimum weight to the assigned value multiplied by 15 Hz. Lighter loads will increase the frequency by the same proportion.

   EXAMPLE: Steel stud wall with 2 layers of 3/4 inch gypsum board weighing 7.9 lbs. per sq/ft. Sway braces on 4 foot centers both ways.

   Assigned Weight = 16 x 7.9 = 126 lbs.
   WIC-1 Selection (Maximum 250 lbs)
   Frequency = 15Hz x $\sqrt{126/250}$ = 10.65 Hz

| DWN | CHKD | DATE |
|---|---|---|
| | | |

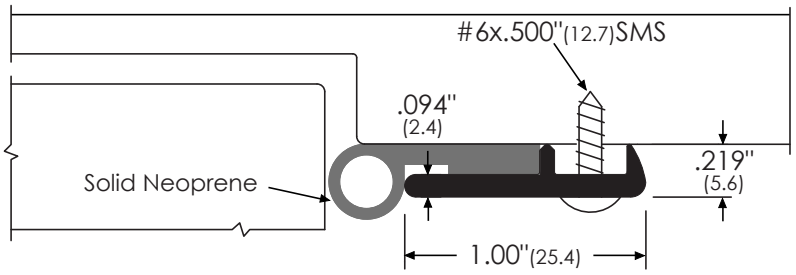
**DWG No.**



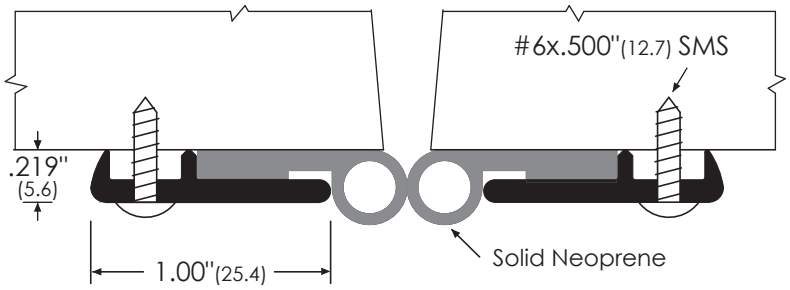

Door Sweep
- Surface Mounted
- Solid Neoprene

FIRE AND SMOKE R ATINGS

- UL listed
- ITS Warnock Hersey listed
- 10B Classified up to 90 minutes
- 10C Classified up to 90 minutes
- Category H Classified under UL 1784, listed up to 180 minutes




Head and Jamb Protection
- Stop Applied
- Solid Neoprene




Meeting Stile, Both Doors Active
- Surface Mounted
- Solid Neoprene

ZERO INTERNATIONAL

415 Concord Avenue
Bronx, NY 10455
tel: 718.585.3230
fax: 718.292.2243
email: zero@zerointernational.com
web site: www.zerointernational.com

**Part No:** 328

**Notes:**

**Part Description:** See above for options

| Provided By: | Customer Name: | Job No: | Date: |
|---|---|---|---|
| | | | |

IMPACTA
Acoustical Floor Underlayments

## Acoustical Underlayment for Linoleum, VCT, Sheet Vinyl & Vinyl Plank Flooring

**Jumpax** is a free floating, dry levelling, sound reducing, time and money saving fast track underlay system. Jumpax is capable of creating a super smooth joint less surface for direct glue down of resilient floor coverings such as linoleum, sheet vinyl, VCT, LVT, vinyl plank, cork floors and PSA backed carpets. Jumpax underlay is suitable for commercial and residential use. The dual underlayment system consists of a composed based board and a calibrated top board and is the best underlay system in terms of levelling and impact sound reduction.

Jumpax systems have been installed in universities, hospitals, condominiums, apartments, hotels and resorts and commercial places all over the world. In addition, it has been installed in commercial and public buildings to prevent high-traffic passages on the floors above from intruding conference, office and meeting areas.

Jumpax can easily be installed over concrete, gypsum topping or APA plywood on existing floors, new construction or renovations.

### Product Specification:

| | |
|---|---|
| **Total thickness** | 10 mm / 3/8” |
| **Board Size** | 23 ⅝” x 47 ¼” |
| **Boards per package** | 4 ea top & bottom |
| **Quantity per package** | 31 sq ft |
| **Weight – sq ft** | 1.35 lbs per sq ft |
| **Weight per package** | 42 lbs |

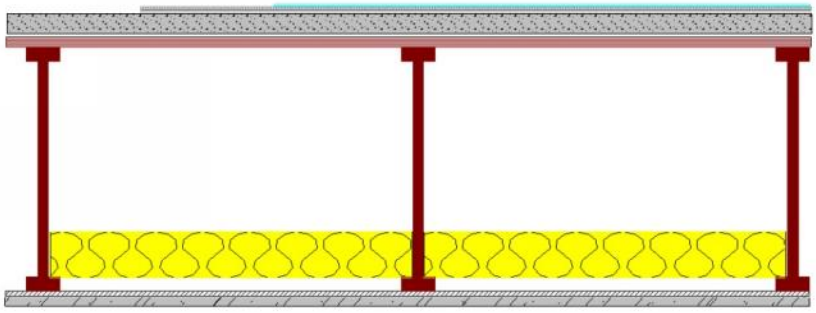
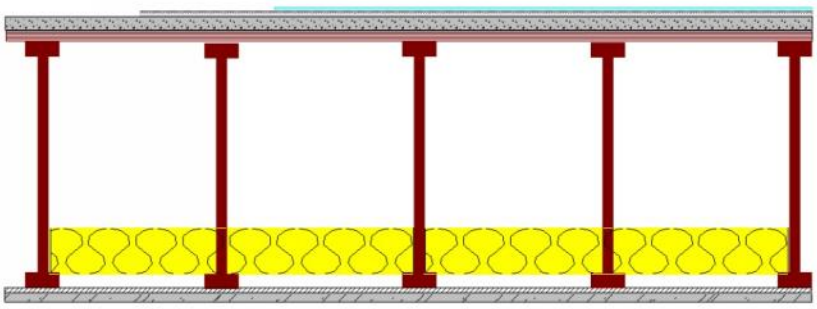
**Acoustics performance on back page**


**Advantage of Using Jumpax**

- **Fast Track Floor Prep** saves time and money on floor preparation
- **Outstanding Floor Leveling** up to 1/8”over 3ft up to 1/4" over 10 foot span
- **Sound Reducing Qualities** ideal for universities, hospitals, condominiums, apartments, hotels, resorts and commercial places
- **Super Smooth Surface** for joint less direct glue down of resilient floor coverings

**Distributed by:**

# Jumpax Acoustical Testing

| Description | Detail | IIC / FIIC Rating |
|---|---|---|
| **Jumpax**<br><br>Glue down vinyl over 10mm Jumpax over 6" slab |  | **Δ 25 / IIC 53** |
| **Jumpax**<br><br>Glue down vinyl over 10mm Jumpax over 1 ½" gypsum topping over 5/8" plywood- 16" TJI – 24 centers RC1 channel – 1 layer 5/8 GWB |  | **IIC 54** |
| **Jumpax**<br><br>Glue down vinyl over 10mm Jumpax over 1" gypsum topping over 5/8" plywood - 16" TJI – 16 centers RC1 channel – 1 layer 5/8 GWB |  | **FIIC 57** |
| **Jumpax**<br><br>Glue down vinyl over 10mm Jumpax over 8" slab |  | **FIIC 61** |

For more information on Jumpax Underlayment systems including installation instructions, installation videos, accessories and technical data please go online at www.Jumpax.net or call us toll free at 800-569-1294

# VC300

IMPACTA
Acoustical Floor Underlayments

## Acoustical Underlayment for Sheet Vinyl, Linoleum, LVT, Vinyl Plank & adhesive backed Carpet Tile

Impacta VC300 is a tough, resilient acoustic underlay that has been specially manufactured for resilient vinyl floors. Manufactured from PUR foam & cork granules and is ideally suited for all new construction for glue down vinyl floors. VC300 is rubber free so there will be no issues with discoloration of the vinyl due to plasticizer migration which is a common occurrence with rubber/vinyl adhesive reaction. VC300 is Green Circle Certified containing both pre-consumer recycled content and rapid renewable material. VC300 is only 3mm thick but offers excellent acoustical performance as well as durability under point loads and has been tested with point loads under various vinyl floors with results up to 250 PSI ratings.

### Benefits of using VC300

- Offers long term performance without collapse or bottoming out
- Suitable for both new construction & renovations
- Quick & easy installation
- Resistant to ageing & deformation

**Product Specification:**

| | |
|---|---|
| **Nominal thickness** | 3mm or 1/8" |
| **Roll Size** | 39" x 62' |
| **Sq. Ft. per Roll** | 201.5 |
| **Weight per roll** | 65 lb |
| **Recycled Content** | 72% pre consumer<br>18% rapidly renewable |
| **Density** | 420 kg/m³ |
| **Tensile** | 0.7N/mm² |
| **Temperature range** | -40 to + 110º F |
| **Thermal resistance** | 0.025 k/w |

**Acoustics performance on back page**

**Important Note:** When comparing alternate products please be aware that recycled rubber is not compatible and should never be used under any vinyl floor. Recycled rubber contains plasticizer that will chemically react with the vinyl floor and cause the floor to failure

**Vinyl Composition Tile (VCT)** should not be installed over VC300. Jumpax would be correct product with VCT

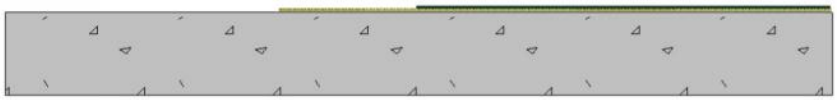
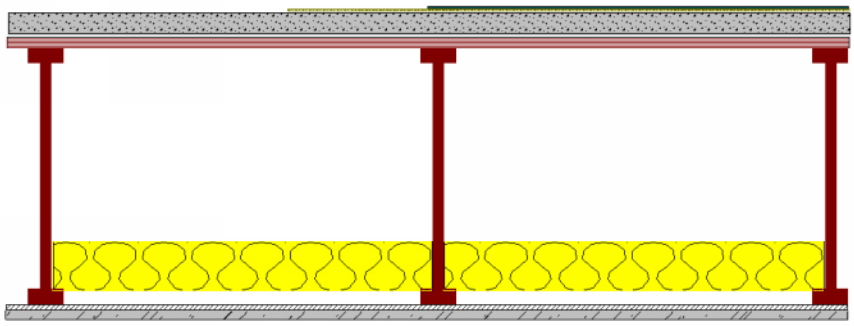
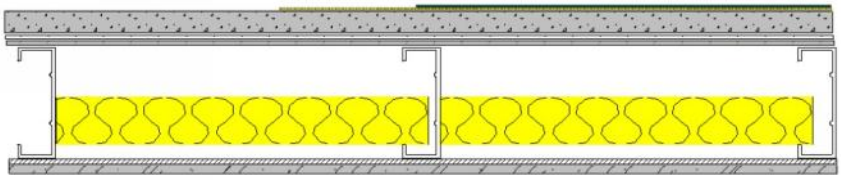
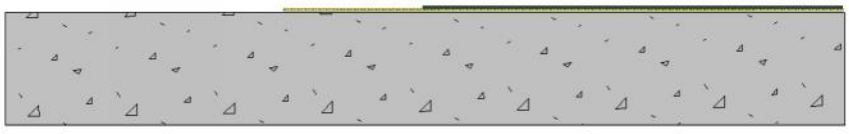
A SUSTAINABLE SOLUTION
GreenCircle CERTIFIED ™

### Bond Coat

VC300 can be installed to concrete gypsum topping & APA plywood with Impacta T-700 bond coat adhesive.


**Distributed by:**

# VC300 Acoustical Testing

| Description | Detail | IIC / FIIC Rating |
|---|---|---|
| **VC300**<br><br>Glue down vinyl over 3mm VC300 over 6” slab |  | **Δ 22 / IIC 50** |
| **VC300**<br><br>Glue down vinyl over 3mm VC300 over 1 ½” gypsum topping over 16” TJI – 24 centers RC1 channel – 1 layer 5/8 GWB |  | **IIC 55** |
| **VC300**<br><br>Glue down vinyl over 3mm VC300 over 1 9/16” gypsum topping over 8" Dietrich TradeReady Floor Joist @ 24"o.c. WAVE Suspended Drywall Grid, 3-1/2" Batt – 1 layer 5/8 GWB |  | **IIC 51** |
| **VC300**<br><br>Glue down vinyl over 3mm VC300 over 8” slab |  | **FIIC 64** |

For more information on VC300 Underlayment system including installation instructions, installation videos, accessories and technical data please go online at www.VC300.com or call us toll free at 800-569-1294

## Appendix E – LEED for Schools v4 Project Scorecard

# LEED for Schools v4
# Project Scorecard

| | |
|---|---|
| Bld SF: | |
| Site SF: | |
| FTEs: | |
| Visitors: | |
| Parking #: | |

Project Name: Gibbs School
Project Address:
Date Updated: Nov. 9, 2016

**Targeted LEED v4 Rating:**

| Phase | Yes | ? | No | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 0 | | **Integrative Process** | 1 | **Notes** |
| D | 1 | | | Credit 1 | **Integrative Process** | 1 | Credit requires identifing and using opportunities to achieve synergies across disciplines and building systems. Includes studies on Lighting levels, Thermal comfort, and Plug and process loads |

| | Yes | ? | No | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 8 | 3 | | **Location & Transportation** | 15 | **Notes** |
| D | | | 0 | Credit 1 | **LEED for Neighborhood Development Location** | 15 | |
| D | 1 | | | Credit 2 | **Sensitive Land Protection** | 1 | not in area with wetlands, water body, farmlands,etc |
| D | | | 2 | Credit 3 | **High Priority Site** | 2 | |
| D | 2 | 3 | | Credit 4 | **Surrounding Density and Diverse Uses** | 5 | in a dense area and neighborhood has access to amenities |
| D | 1 | 3 | | Credit 5 | **Access to Quality Transit** | 4 | at least 1 point for access to buses |
| D | | | 1 | Credit 6 | **Bicycle Facilities** | 1 | no showers in school |
| D | | 1 | | Credit 7 | **Reduced Parking Footprint** | 1 | parking is limited. Carpool parking might not be a good fit for this project |
| D | | 1 | | Credit 8 | **Green Vehicles** | 1 | parking is limited. Electric charging stations might not be a good fit for this project. A hookup for a future charging station was discussed |

| | Yes | ? | No | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 9 | 2 | | **Sustainable Sites** | 12 | **Notes** |
| C | Y | | | Prereq 1 | **Construction Activity Pollution Prevention** | Required | |
| D | Y | | | Prereq 2 | **Environmental Site Assessment** | Required | |
| D | | 1 | | Credit 1 | **Site Assessment** | 1 | a site assessment could be done. |
| D | | | 2 | Credit 2 | **Site Development - Protect or Restore Habitat** | 2 | |
| D | | 1 | | Credit 3 | **Open Space** | 1 | Need to provide outdoor space greater than or equal to 30% of the total site area. A minimum of 25% of that outdoor space must be vegetated (turf grass does not count as vegetation) or have overhead vegetated canopy. |
| D | | 3 | | Credit 4 | **Rainwater Management** | 3 | Requires managing on site the runoff from the developed site for the 95th percentile of regional or local rainfall events using low-impact development (LID) and green infrastructure. |
| D | | 2 | | Credit 5 | **Heat Island Reduction** | 2 | Need a light colored roof and light colored surfaces to achieve this credit. |
| D | | 1 | | Credit 6 | **Light Pollution Reduction** | 1 | Full cut off lighting will be installed. Calculations will need to be done to determine credit compliance |
| D | | 1 | | Credit 7 | **Site Master Plan** | 1 | This was not discussed yet |
| D | 1 | | | Credit 8 | **Joint Use of Facilities** | 1 | This should be easy to meet |

| | Yes | ? | No | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 3 | 6 | | **Water Efficiency** | 12 | **Notes** |
| D | Y | | | Prereq 1 | **Outdoor Water Use Reduction** | Required | |
| D | Y | | | Prereq 2 | **Indoor Water Use Reduction** | Required | |
| D | Y | | | Prereq 3 | **Building-level Water Metering** | Required | |
| D | 2 | | | Credit 1 | **Outdoor Water Use Reduction** | 2 | Efficient irrigation system will be installed |
| D | | 1 | 6 | Credit 2 | **Indoor Water Use Reduction** | 7 | May receive a point for low flush/low flow fixtures. Calculations will need to be done to determine |
| D | | 2 | | Credit 3 | **Cooling Tower Water Use** | 2 | Is it water cooled or air cooled chiller? |
| D | 1 | | | Credit 4 | **Water Metering** | 1 | Confirmation will be needed on water metering |

| | Yes | ? | No | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 9 | 16 | | **Energy & Atmosphere** | 31 | **Notes** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C | Y | | | Prereq 1 | **Fundamental Commissioning and Verification** | Required | |
| D | Y | | | Prereq 2 | **Minimum Energy Performance** | Required | |
| D | Y | | | Prereq 3 | **Building-level Energy Metering** | Required | |
| D | Y | | | Prereq 4 | **Fundamental Refrigerant Management** | Required | |
| C | 3 | 1 | 2 | Credit 1 | **Enhanced Commissioning** | 6 | CxA will be performed. Enhanced commissioning may require some additional cost. |
| D | 3 | 2 | 11 | Credit 2 | **Optimize Energy Performance** | 16 | Further discussions will be needed to determine if points will be achieveable |
| D | | 1 | | Credit 3 | **Advanced Energy Metering** | 1 | Discussion needed. Requires installing advanced energy metering for the following:<br>· all whole-building energy sources used by the building; and<br>· any individual energy end uses that represent 10% or more of the total annual consumption of the building. |
| C | | 2 | | Credit 4 | **Demand Response** | 2 | most likely not a good option. Discussion needed. |
| D | | | 3 | Credit 5 | **Renewable Energy Production** | 3 | |
| D | | 1 | | Credit 6 | **Enhanced Refrigerant Management** | 1 | Calculations will need to be performed to determine. |
| C | | 2 | | Credit 7 | **Green Power and Carbon Offsets** | 2 | Green power could be purchased if additional points are needed. |

| Yes | ? | No | | | | |
|---|---|---|---|---|---|---|
| 2 | 8 | 3 | | **Materials & Resources** | **13** | **Notes** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D | Y | | | Prereq 1 | **Storage & Collection of Recyclables** | Required | |
| C | Y | | | Prereq 2 | **Construction and Demolition Waste Management Planning** | Required | |
| C | | 5 | | Credit 1 | **Building Life-cycle Impact Reduction** | 5 | If at least 25% of building materials are reused or salvaged (as a percentage of the surface area), we can achieve a point. |
| C | | 1 | 1 | Credit 2 | **Building Product Disclosure and Optimization**-Environmental Product Declarations | 2 | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | | 1 | 1 | Credit 3 | **Building Product Disclosure and Optimization**-Sourcing of Raw Materials | 2 | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | | 1 | 1 | Credit 4 | **Building Product Disclosure and Optimization**-Material Ingrediants | 2 | We will keep these points as Maybe for now to be conservative as they are difficult to achieve. |
| C | 2 | | | Credit 5 | **Construction and Demolition Waste Management** | 2 | Project will divert at least 75% of construction waste from at least Four Material Streams |

| Yes | ? | No | | | | |
|---|---|---|---|---|---|---|
| 6 | 8 | 2 | | **Indoor Environmental Quality** | **16** | **Notes** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D | Y | | | Prereq 1 | **Minimum IAQ Performance** | Required | |
| D | Y | | | Prereq 2 | **Environmental Tobacco Smoke (ETS) Control** | Required | |
| D | Y | | | Prereq 3 | **Minimum Acoustical Performance** | Required | |
| D | 2 | | | Credit 1 | **Enhanced IAQ Strategies** | 2 | Project will have walk off mats, MERV 13 filters, and carbon dioxide monitoring |
| C | 1 | 1 | 1 | Credit 2 | **Low-Emitting Materials** | 3 | Specifications can be written to help achieve at least one point for this credit |
| C | 1 | | | Credit 3 | **Construction IAQ Management Plan** | 1 | Project will develop and implement an indoor air quality (IAQ) management plan |
| C | | 1 | 1 | Credit 4 | **IAQ Assessment** | 2 | Flushout is a weak maybe. Timeline for occupancy after construction completion will be tight |
| D | 1 | | | Credit 5 | **Thermal Comfort** | 1 | Need confirmation that HVAC systems will be designed to meet requirements of ASHRAE Standard 55–2010 |
| D | 1 | 1 | | Credit 6 | **Interior Lighting** | 2 | Quality lighting option will be difficult to achieve. Confirmation needed that at least 90% of individual occupant spaces will have individual lighting controls. Multi occupant spaces should meet light requirements. |
| D | | 3 | | Credit 7 | **Daylight** | 3 | Calculations / modeling would need to be done to determine if this credit is achieveable |
| D | | 1 | | Credit 8 | **Quality Views** | 1 | Calculations would need to be done to determine if this credit is achieveable |
| D | | 1 | | Credit 9 | **Acoustic Performance** | 1 | This credit would need to be discussed |

| Yes | ? | No | | | | |
|---|---|---|---|---|---|---|
| 6 | 0 | 0 | | **Innovation** | **6** | **Notes** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D | 1 | | | Credit 1 | **Innovation in Design: Green cleaning** | 1 | Green cleaning was discussed |
| D | 1 | | | Credit 2 | **Innovation in Design: Building as an educational tool** | 1 | Building as an educational tool was discussed |
| D | 1 | | | Credit 3 | **Innovation in Design: To be determined** | 1 | |
| C | 1 | | | Credit 4 | **Innovation in Design: To be determined** | 1 | |
| C | 1 | | | Credit 5 | **Innovation in Design: To be determined** | 1 | |
| C | 1 | | | Credit 6 | **LEED Accredited Professional** | 1 | |

| Yes | ? | No | | | | |
|---|---|---|---|---|---|---|
| 0 | 2 | 2 | | **Regional Priority Credits - earn up to 4 points** | 4 | |
| | | | | Area code: 02474 | | |
| | | 1 | Credit 1 | **Renewable Energy Production** (threshold: 2 points) | 1 | |
| | | 1 | Credit 2 | **Optimize Energy Performance** (threshold: 8 points) | 1 | |
| | 1 | | Credit 3 | **High Priority Site** (threshold: 2 points) | 1 | |
| | 1 | | Credit 4 | **Rainwater Management** (threshold: 2 points) | 1 | |
| | 1 | | Credit 5 | **Cooling tower water use** | | |
| | 1 | | Credit 6 | **Building Life-Cycle Impact Reduction** (threshold: 2 points) | | |

| Yes | ? | No | | |
|---|---|---|---|---|
| 29 | 47 | 34 | **Project Totals (Certification Estimates)** | 110 |

**Certified:** 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points

11-16 points needed

**Other sustainable topics discussed:**

Reused/reclaimed materials - at entrance of school
FSC wood
Low maintenance flooring
Community garden
Diverting food waste in kitchen - goal of composting food waste
Dashboard to show building's energy consumption
EMS system
Project will have bike racks